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DISCUSSION OF GEOLOGY, HYDROGEOLOGY, AND WATER QUALITY OF THE TAILINGS AREA
Molycorp Facility
Taos County, New Mexico

prepared for
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Discussion of Geology, Hydrogeology, and Water Quality of the Tailings Area

TABLE OF CONTENTS

	Page
LIST OF APPENDICES	ii
LIST OF FIGURES	ii
LIST OF TABLES	ii
1.0 INTRODUCTION	**1**
1.1 INTRODUCTION	1
1.2 SUMMARY OF FALL 1994 AND PREVIOUS INVESTIGATIONS	2
2.0 GEOLOGY AND HYDROGEOLOGY	**5**
2.1 REGIONAL GEOLOGY	5
2.2 TAILINGS AREA GEOLOGY AND HYDROGEOLOGY	6
3.0 RESULTS AND DISCUSSION OF FALL 1994 FIELD ACTIVITIES IN THE TAILINGS AREA	**8**
3.1 WELL EMPLACEMENTS AND WATER LEVELS	8
3.2 HYDROGEOLOGIC CONDITIONS AND WATER-QUALITY ASPECTS SOUTH OF THE DAM NO. 1 ARROYO	9
3.3 HYDROGEOLOGIC CONDITIONS AND WATER-QUALITY ASPECTS SOUTH OF THE DAM NO. 4 ARROYO	10
3.4 IMPACT ON THE RED RIVER	11
4.0 REFERENCES	**15**

TAILINGS AREA

LIST OF APPENDICES

Appendix A: Detail of Tailings Area Site Geology
Appendix B: Detail of Tailings Area Hydrology and Hydrogeology
Appendix C: Tailings Area Borehole and Geophysical Logs (from Fall 1994 Field Investigation)
Appendix D: Tailings Area Water-Quality Data
Appendix E: Data from Tailings Area Aquifer Drawdown and Recovery Tests

LIST OF FIGURES

Figure 1: Regional Location Map
Figure 2: Tailings Area Site Map
Figure 3: Generalized Geologic Cross-Section
Figure 4: Geologic Cross-Section South of Dam No. 1.
Figure 5: Hydrogeologic Cross-Section South of Dam No. 1.
Figure 6 : Water Quality Survey: Monitor Wells and the Red River

LIST OF TABLES

Table 1: 1994 Monitor Well Water-Quality Data for Tailings Area
Table 2: Historical Water-Quality Data for Private Wells
Table 3: Water Quality Data from Sampling Along the Red River

1.0 INTRODUCTION

1.1 INTRODUCTION

The Molycorp molybdenum mine is located on the western slope of the Taos Range of the Sangre de Cristo Mountains, Taos County in north-central New Mexico (Figure 1). State Highway 38 runs along the north side of the Red River and connects the mine area with the Town of Red River (6 miles to the east) and the Town of Questa (6 miles to the west). For the purposes of this report, the area consisting of tailings embankments, tailings ponds, seepage controls, and outfall facilities is defined as the ***Tailings Area***. The Tailings Area is located about 1 mile west of the town of Questa and 0.5 mile north of the Red River (Figure 2).

In 1989, Molycorp retained the services of South Pass Resources, Inc. (*SPRI*) to evaluate impacts of past and present Molycorp mining operations on ground-water and surface-water quality. SPRI's most recent (Fall 1994) activities have involved the design, installation, and testing of five (5) new monitor/extraction wells in the Tailings Area. This report presents a discussion of the Fall 1994 investigation and of previous investigations, of the geologic, hydrogeologic, and water-quality aspects of the Molycorp mining activities.

<u>HISTORY OF INVESTIGATIONS</u>

Molybdenum ore was discovered in the Questa area in 1916. Original underground mining was replaced in 1964-1965 with open-pit excavations and increased milling activities. Starting in 1979, mining was once again diverted to underground operations. Coincident to increasing mining activities, tailings-disposal operations were initiated by 1965 with completion of Dam No. 1 and the Dam No. 1 tailings pond.

A number of studies have investigated the geology and hydrogeology of the area (see Section 4.0, References). Regional studies were conducted by I. Winograd (1959); the U.S. Army Corps of Engineers from 1936-46 in conjunction with a dam-siting study at Chiflo; and others. Beginning in the early 1980s, more site-specific investigations were commissioned by Molycorp. These studies were designed to focus on ground-water flow patterns, surface-water and ground-water quality, and relationships between tailings disposal activities and any down-gradient water quality. The site-specific studies have been conducted predominately in two locations:

- Guadalupe Mountain and south (to the Red River) and west (to the Rio Grande); and

- The area between Red River and tailings Dams Nos. 1 and 4 (the Tailings Area of this report).

Geoscience and engineering consulting firms that have conducted most of the studies since the early 1980s include: Dames & Moore, Harding-Lawson, South Pass Resources, Inc. (SPRI: formerly the GeoWest Group), Vail Engineering, and Water Resources Associates.

Considerable information has now been generated on the geology, hydrogeology, and water quality within the Tailings Area, as well as the interrelationships between these three parameters. In March 1993, a Ground-Water Discharge Plan Permit Application for the Tailings Area was submitted to the New Mexico Environmental Improvement Division (NMEID). This report presents the findings from SPRI's recent (Fall 1994) field investigation and other investigations in support of the Discharge Plan Permit Application.

1.2 SUMMARY OF FALL 1994 AND PREVIOUS INVESTIGATIONS

Between August 28 and September 27, 1994, SPRI overviewed the installation and testing of one monitor and four extraction wells in the Tailings Area. The purpose of this field effort was to:

- further delineate ground-water flow patterns between the tailings ponds and the Red River;
- further identify the geologic controls on ground-water flow;
- further characterize perched-water conditions in the Tailings Area;
- continue the investigation of contaminant flow paths from the tailings ponds; and
- emplace extraction wells for potential remediation efforts.

The wells that were installed during the Fall 1994 field effort, and the details of their installation and testing, are summarized below. The locations of these wells are shown on Figure 2. [All of the wells (except MW-12 which has 4-inch PVC casing) were constructed with 8-inch PVC casing and screen to allow for future pumping and extraction, if desired.]

Tailings Area Monitor/Extraction Wells Installed in August/September 1994			
Well No.	**Total Depth (feet)**	**Screened Interval (feet)**	**Well Completed In**
EW-1	157	83 - 157	basalt/basalt gravel
EW-2	214	104 - 114 120 - 132 151 - 185	sandy gravel sandy gravel, gravelly sand, clay basalt gravel in clay
EW-3	104	62 - 77	sandy clay/clayey gravel
EW-4	58	42 - 58	clayey gravel
MW-12	234	203 - 234	basalt gravel/basalt

These new monitor and exploration wells in the Tailings Area supplement monitor wells previously installed under SPRI direction (see SPRI, 1993; 1994). These wells are summarized below:

Tailings Area Monitor Wells Previously Installed by SPRI (1993)	
Well No.	**Total Depth (feet)**
MW-11	249
MW-7A, -7B, -7C	146
MW-9A, -9B	147
MW-8	225
MW-10A	136

A partial listing of other monitor and extraction wells in the Tailings Area that pre-date SPRI field activities are summarized below. (Note: A complete list of all wells located in the study area is unknown at this time.)

Other Wells Located in the Tailings Area (Partial Listing)		
Well No.	**Total Depth (feet)**	**Year Installed**
Change House (CH)	250	1967
MW-1	117	1979
MW-2	80	1979
MW-3	52	1979
MW-4	102	1979
MW-A	38	NA
MW-B	18	NA
MW-C	15	NA
MW-6	101	NA 1979

Figure 2 shows the locations of SPRI and other wells installed in the Tailings Area.

2.0 GEOLOGY AND HYDROGEOLOGY

The Molycorp study area is located on a broad, westward-sloping alluvial plain that is bound on the east by the Sangre de Cristo Mountains (elevations in the 12,000-foot range) and on the west by the Guadalupe Mountains (elevations in the 8,700-foot range). In the study area, this alluvial plain is the southern extension of Sunshine Valley but is topographically separated from the Valley by a low divide near the town of Cerro, about 3 miles north of Questa.

The Red River lies immediately south of Questa and is a perennial stream that flows from the Sangre de Cristo Mountains to the Rio Grande (5 miles west of Questa). From approximately 2 miles west of Questa to the Rio Grande, the Red River channel is entrenched in a deep gorge developed across the volcanic rocks on the south flank of the Guadalupe Mountains.

2.1 REGIONAL GEOLOGY

The Molycorp site is located within the Rio Grande rift zone, a northeast-/southwest-trending fault-bound structural depression that is Mid- to Late-Tertiary in age and that extends across New Mexico into southern Colorado. The rift zone is composed of a number of structural subbasins including the San Luis Basin. The San Luis Basin is located at the northern end of the rift zone and is bounded on the east by the Sangre de Cristo Mountains. The San Luis Basin contains coarser alluvial sediments along the range front. Farther to the west, the basin fill consists of finer clays and silts (deposited in lakes) and finer alluvial material along the distal edge of alluvial fans. To the east, volcanism and intrusion associated with the Questa caldera occurred.

Numerous volcanic fields developed as the result of the rifting and basin formation in Mid- to Late-Tertiary time. The volcanic units that underlie the Guadalupe Mountains along the west side of the site consist of lava flows and ash flow tuffs that range in composition from rhyolite to basalt. The volcanics erupted onto older basin-fill sediments from central vent and fissure eruptions (Winograd, 1959; unpublished reports in the Molycorp files). Eastward toward the uplifted Sangre de Cristo Mountains, the volcanics intertongue with contemporaneous alluvial sediments. Figure 3 (modified from Winograd, 1959) illustrates these stratigraphic relationships. A younger (Pliocene) basalt unit, the Servilleta Basalt, overlies these older volcanic units and intertongues with correlative basin-fill sediments. Winograd (1959) referred to the interlayered sedimentary and volcanic units filling the San Luis Basin in the Sunshine Valley areas as the Santa Fe Group.

2.2 TAILINGS AREA GEOLOGY AND HYDROGEOLOGY

Geology

The Tailings Area is characterized by both volcanic rocks (rhyolites to basalts) intertongueing with or overlain by alluvial sediments and lacustrine deposits (the Santa Fe Group). Stratigraphic interpretations in the Tailings Area are based on 14 borehole logs and 3 geophysical logs, supplemented by field observations and unpublished maps (Vail, 1987; Molycorp files). Figure 4 illustrates the stratigraphy of the Tailings Area. The Santa Fe Group stratigraphy consists of :

- An Upper Aquifer Unit (UAU) composed of brown sandy gravels and gravelly sands with some pale red brown silty, sandy clay;
- a Middle Aquitard Unit (MAU) composed of pale red brown clay and gravelly clay;
- a Lower Aquifer Unit (LAU) composed of sandy or clayey gravel, with some thin, cemented sand units; and
- a Basal Aquitard Unit (BAU) composed of bouldery clay.

There are five recognized northeast-trending faults (see Appendix A for detailed discussion) in the Tailings Area that, in areas, bring volcanic rocks into lateral contact with the Santa Fe Group alluvial materials.

Hydrogeology

SAF Beneath

The major regional aquifer is in the basalt and older volcanics beneath the Santa Fe Group. Within the Santa Fe Group alluvium, lateral hydraulic conductivities are considered higher than vertical hydraulic conductivities. Field investigations demonstrate that perched zones in the UAU and a main perched zone involving the lower UAU and upper MAU overlie a regional water table in the LAU and basalt aquifer (see Figure 5).

A limited number of aquifer tests were conducted in the Tailings Area. Horizontal hydraulic conductivities for these tests ranged from approximately 87 gallons per day per square foot (gpd/ft^2) to 913 gpd/ft^2. These values are compatible with average hydraulic conductivities for sands and gravels. Vertical hydraulic conductivities from laboratory tests were about 0.01 to 73 gpd/ft^2. The finer-grained beds would significantly reduce the vertical migration of leachate.

Hydraulic conductivity values calculated from an aquifer test at MW-11 for the basalt aquifer ranged from 6,833 gpd/ft^2 (specific capacity calculation) to 14,103 gpd/ft^2 (recovery test). These values are within the range of published values for permeable basalt.

The ground-water gradient is to the south at 0.07 ft/ft in the shallow perched zones and to the southwest at 0.016 ft/ft in the underlying main perched zone. There are not enough data points to evaluate flow direction and gradients for the LAU and BAU.

Ground-water flow directions in the basalt aquifer range from S20°W to S75°W. These are based on three-point calculations from water-level data measured at Guadalupe Mountain (Dames and Moore, 1986), by SPRI in the Dam No. 4 area, and from a potentiometric map for the volcanic aquifer (Winograd, 1959). Hydraulic gradients range from 0.003 ft/ft to 0.1 ft/ft. Steeper gradients are related to localized discharge conditions such as occur along permeable fault zones (e.g., MW-11 area).

With some exceptions, near-surface ground water in the Tailings Area can now be categorized as a calcium sulfate water. The regional ground water is a sodium potassium or a calcium bicarbonate water. Most perched ground water has high total dissolved solids (TDS) and high sulfate.

Appendix A contains a detailed discussion of the Tailings Area site geology. Appendix B contains detailed discussions of the hydrology of the tailings dams plus the hydrogeology of the areas between Dam Nos. 1 and 4 and the Red River. Appendix C contains well construction diagrams and geologic and geophysical logs for wells emplaced during SPRI's Fall 1994 investigation. Appendix D contains detailed discussions of ground-water quality. Appendix E contains data from three aquifer drawdown and recovery tests.

3.0 RESULTS AND DISCUSSION OF FALL 1994 FIELD ACTIVITIES IN THE TAILINGS AREA

3.1 WELL EMPLACEMENTS AND WATER LEVELS

During SPRI's Fall 1994 investigation, five wells were installed. (Aquifer tests were conducted on three of these wells.)

- EW-1: 157 feet total depth (TD)
- EW-2: 214 feet TD
- EW-3: 104 feet TD
- EW-4: 58 feet TD
- MW-12: 234 feet TD

Well EW-1 is screened in the basalt aquifer and, like the nearby MW-1, has a water level close to the basalt/LAU contact. EW-1 was located between MW-1 (also screened in basalt) and a potential source of leachate from the Dam No. 4 tailings pond. The purpose for EW-1 was to evaluate water chemistry and to position an extraction well for remediation of Dam No. 1 and Dam No. 4 leachate, if necessary.

Wells EW-3 and EW-4 are both screened in a gravelly zone within the main perched zone to evaluate their capacity for extracting Dam No. 1 leachate. Water-level elevations at both of these wells are related to the water table for the main perched zone. These wells were also designed for leachate extraction, if practicable.

Wells EW-2 and MW-12 are deep wells located south of Dam No. 1. The purpose of these wells was to evaluate the LAU and the basalt aquifer, respectively. EW-2 was designed to also function as a leachate extraction well in the LAU, if necessary. With the discovery of the previously unknown bouldery clay beneath the LAU aquifer, this well was extended to evaluate water quality in the deeper sedimentary unit. The EW-2 water level is related to a zone of confined gravel within the bouldery clay unit below the LAU. Well MW-12 was drilled to evaluate the perched zone first noted at the nearby MW-9 well and to test the water quality in the basalt aquifer on the east side of the Dam No. 1 arroyo. The water level in the well is above the sediment/basalt contact as the result of confined conditions related to the overlying clay unit.

Results of the most recent water quality sampling (Fall 1994) for wells located in the Tailings Area are presented on Table 1.

3.2 HYDROGEOLOGIC CONDITIONS AND WATER-QUALITY ASPECTS SOUTH OF THE DAM NO. 1 ARROYO

The deeper private wells (P-4B and P-5) south of the tailings ponds have good quality water in terms of TDS and sulfate (Table 2). Well P-4B is a deep well (175 feet TD), is partly screened in the volcanic unit, and is partly in the overlying sedimentary material. Well P-5 is 131 feet deep, which is enough to be into the LAU (perforated interval unknown). Well P-5 may be east of an LAU flow path from the Tailings Area.

South of the Molycorp boundary, hydrogeologic data on the Santa Fe Group alluvial section is incomplete. The main perched zone may extend to the river. The shallower private wells between the Molycorp property line and the river (P-1: 90 feet TD; and P-8: 67 feet TD) have high concentrations of TDS and sulfate and are probably screened in portions of the lower UAU and MAU (equivalent to the main perched zone to the north). Some of the springs near the river have elevated sulfate concentrations (Vail, 1993). It is also possible that the main perched zone merges with the LAU toward the river; however, because of upward head conditions leachate-impact of the LAU would be prevented. The water-level elevation contours drawn on the top of the main perched zone in the area just south of Dam No. 1 would, if extended to the south, curve eastward because the Red River is probably a gaining stream along the segment of its course opposite the dams and upstream from the Pope Lake wash.

Vail (1993) recorded a sulfate concentration of 504 mg/L from a field spring in the vicinity of Big Springs (Table 2). In Vail's report, the cold spring water piped to the Fish Hatchery came from Questa Spring (part of the Big Spring Complex). However (Vail, personal communication, 1994), indicates that the source of the Hatchery cold water is a spring in the fields just east of the Questa Spring. This spring water has a sulfate content of 80 mg/L. It appears that the shallower alluvial units (UAU/MAU) are the probable sources of the poorer quality water and that some of the spring water comes from deeper sources in the Santa Fe Group (LAU) or the basalt. All of these springs are located within the postulated fault zone south of Dam No. 1 identified in the Tailings Area. Water may migrate upward along fractures from different levels in the Santa Fe Group or the basalt aquifer.

As indicated earlier in this report, seepage from shallow perched zones in the UAU along the east side of the pond at Dam No. 4 is partially captured by Seepage Barrier 002. No perched zones were identified in the Santa Fe sediments when EW-1 was drilled. The sulfate and TDS concentrations in EW-1 and MW-1, however, may be related to westerly flow of the shallow ground water south of Dam No. 1. Leachate may leak westward across the fault zone on the west side of Dam No. 1.

3.3 HYDROGEOLOGIC CONDITIONS AND WATER-QUALITY ASPECTS SOUTH OF THE DAM NO. 4 ARROYO

Ground-water flow directions range from S20°W to S75°W in the basalt (volcanic) aquifer. These are based on three-point calculations from water-level data at Guadalupe Mountain (Dames and Moore, 1986), south of Dam No. 4 (SPRI 1993, 1994) , and from a potentiometric map for the volcanic aquifer (Winograd, 1959).

Hydraulic gradients range from 0.003 ft/ft to 0.1 ft/ft. Steeper gradients are related to discharge conditions such as occur along permeable fault zones (e.g., MW-11 area). The water-level elevation at MW-11 (7,153 feet) corresponds to a stream bed elevation on the Red River approximately 1,500 feet west of the confluence of Pope Lake Wash (MW-11 area) and the river. Allowing for a water table below the stream bed, it still appears that the Red River may be, for a short segment in the upper Red River Gorge, a losing stream. Discharge from the river may occur along a permeable northeast-trending fault zone located west of Dam No. 4. The steepening of the hydraulic gradient (Winograd, 1959) across this area may be related to discharge along the fault zone. Stream gauge data indicate overall gaining conditions between Questa Ranger Station and the Fish Hatchery in the Red River Gorge. If there is flow loss at the fault zone, it is not enough to be noticed in the stream gauge data.

SPRI (1994), on the assumption of a southwesterly flow direction, estimated an underflow rate in the basalt aquifer to account for the low sulfate concentration at MW-11. A mixing formula (Hem, 1970) was used to calculate a flow rate:

$$Cm = \frac{\sum_{1}^{n} CnQn}{\sum_{1}^{n} Qn}$$

where	C_m	=	sulfate concentration of the river, in mg/L
	C_n	=	sulfate concentration of tributary sources, in mg/L
	Q	=	flow rate, in cubic feet per second (cfs)
	n	=	number of sample points

A major element in this calculation is the pond seepage rate which ranges from 0.5 to 1.5 cfs (Geocon, 1983). The higher seepage rate resulted in an underflow on the order of 19.7 cfs, roughly double the flow rate estimated from studies along the Rio Grande. The lower seepage rate resulted in a more reasonable underflow on the order of 6 cfs. The actual rate may be even lower because:

- A vadose zone (partly alluvial, partly basalt) of approximately 190-foot thickness beneath the pond would attenuate the sulfate concentration entering the ground water.

- The sulfate concentration for the pond water below Dam No. 4 may be less than the combined 002/003 Outfall water at the Red River used in the calculations.

Monitoring of water quality at MW-11 and along the Red River indicates that the rate of ground-water flow in the basalt aquifer causes significant dilution of any pond leachate that may migrate through the thick vadose zone to the water table.

3.4 IMPACT ON THE RED RIVER

Data from two U.S. Geological Survey stream gauges have been used to evaluate the impacts of tailings water on the Red River: one at the Ranger Station (1.5 miles east of Questa), and the other at the confluence of the Red River with the Rio Grande River (a distance of 8.1 miles). The section of the Red River that may be impacted by the tailings ponds is 1.84 miles in length (roughly from the 002/003 Outfall west to the area of the Fish Hatchery). Water levels for wells near the river are close to, but above, river level which indicates that the Red River is a gaining stream for the segment opposite Dam No. 1.

Accretions from tributary sources to segments of the Red River between the gauges have been studied by Wilson and Associates (1978), Water Resources Associates (1984), Dames and Moore (1987), and Vail (1993). These different studies generally conclude that the net gain between Questa and the confluence is roughly 30 cfs. Vail (1993) provides the most recent and detailed estimates for tributary source discharges and their sulfate concentrations to the Red River. Water-quality data from sampling along the Red River are provided on Table 3, and sampling locations (and corresponding sulfate concentrations) are shown on Figure 6. Accretion estimates for the area from the Big Springs Complex (which includes Questa Springs) eastward to the highway bridge over the Red River (the alluvial segment) are given below.

	Flow Rate (Q) (cfs)	Sulfate Concentration (C) (mg/L)
Cold springs from alluvium east of Red River Gorge		
piped to Fish Hatchery	2.7	80
directly to Red River	0.4	80
Field drainage (probably includes seepage from springs east of Big Springs)	2.76	240
002 Outfall (seepage from 001 and 002 barriers)	0.6	840

The estimated rate of flow for the Red River just upstream of the alluvial segment at the highway bridge is 46 cfs and the sulfate concentration is 119 mg/L. Using the values above, the calculation for mixing is:

$$C_m = \frac{\sum_{1}^{n} C_n Q_n}{\sum_{1}^{n} Q_n}$$

$$\frac{(46)(119) + 2.7(80) + 0.4(80) + 2.76(240) + 0.6(840)}{46 + 2.7 + 0.4 + 2.76 + 0.6} = 131.3$$

Based on this calculation, the tributary sulfate input to the Red River directly from the alluvial segment would be diluted to 131.3 mg/L sulfate. A Red River water sample taken 500 feet west of Big Springs Complex has a sulfate concentration of 138 mg/L.

Estimates for tributary sources along the north side of the Red River Gorge (from Big Springs Complex to the Fish Hatchery) are based on estimates of warm spring flow (the assumption, as noted earlier, is that warm water is derived from ground water moving through the volcanic pile).

	Flow Rate (Q) (cfs)	Sulfate Concentration (C) (mg/L)
Warm springs from volcanics directly to the river:		
Warm springs potentially influenced by seepage	1.65	120
Warm springs not influenced by seepage	2.18	20

Adding the inflows from the alluvial segment between the highway bridge and the head of the gorge results in a flow to the upper portion of the gorge on the order of 52 cfs (assuming 138 mg/L sulfate for the Red River below Big Springs). Using the mixing equation and spring flows directly to the river:

$$C_m = \frac{\sum_{1}^{n} C_n Q_n}{\sum_{1}^{n} Q_n} = \frac{(138)(52)+(120)(1.65)+(2.18)(20)}{52+1.65+2.18} = 132.86$$

The sulfate is diluted to 132.86 mg/L. The two Red River samples measured in this segment of the river have sulfate concentrations of 126 and 129 mg/L.

The sulfate concentrations in water samples collected from springs in the upper Red River Gorge are (see Table 3 and Figure 6):

- 115 mg/L for Sample Location 12;
- 126 mg/L for Sample Location 14; and
- 20 mg/L for Sample Location 15.

The water temperatures for these springs were 15.3°C, 14.5°C, and 16.4°C, respectively. Red River water in the same area has a temperature of 10.3 to 11.2°C. The spring temperatures seem to indicate that the springs' source is ground water that is derived from the volcanic aquifer, not river water recharged to the volcanic aquifer along the fault zone near Pope Lake. If the river is discharging to the volcanic aquifer at the fault zone (as suggested by the MW-11 water level), it is not losing much water to the aquifer and temperature effects are not evident.

An issue raised in the SPRI (1994) report regarding the assumption that MW-11 was down-gradient from the pond (southwesterly flow): why would the well have a substantially lower sulfate concentration than the springs farther down-gradient along the Red River? Two possible answers to this question are:

1) There was an earlier pulse of seepage water that had higher sulfate than presently measured (such that the spring samples represent older water than MW-11).

2) There is some iron-sulfide in the basalt that oxidizes in the vadose zone and releases some sulfate to the ground water. The spring at Sampling Location 14 is located on the south side of the Red River and it has a sulfate concentration of 126 mg/L. Localized iron sulfide mineralization in the fracture volcanics on both sides of the river could be supplying the sulfate.

The spring at Sampling Location 15 has a very low sulfate concentration (20 mg/L). It is possible that the higher sulfate springs are discharging water that lies close to the water table and that the water at Sampling Location 15 comes from a deeper source.

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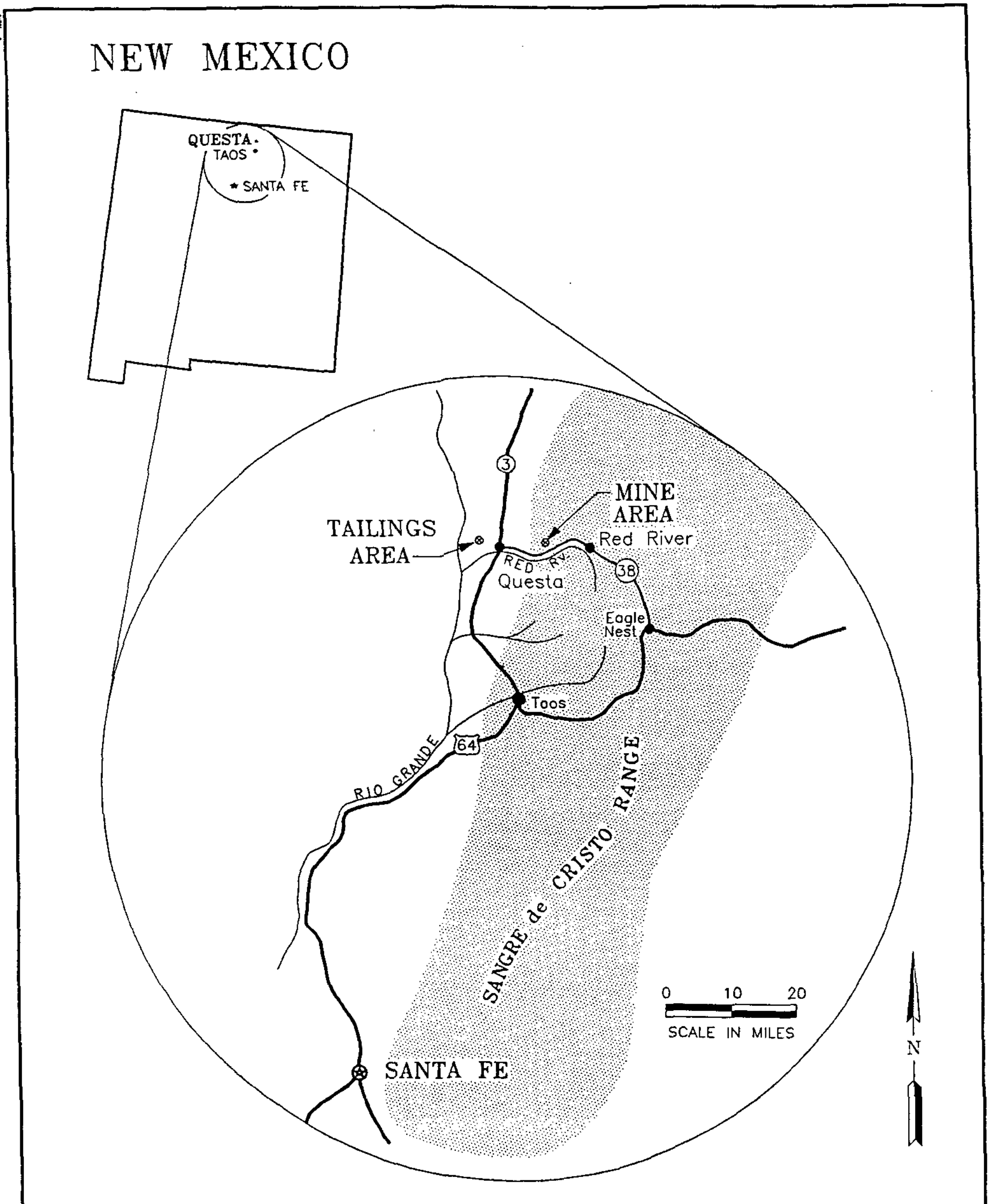

SOUTH PASS RESOURCES, INC.				REGIONAL LOCATION MAP Molycorp, Inc. Questa, New Mexico	FIGURE:
PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.		1

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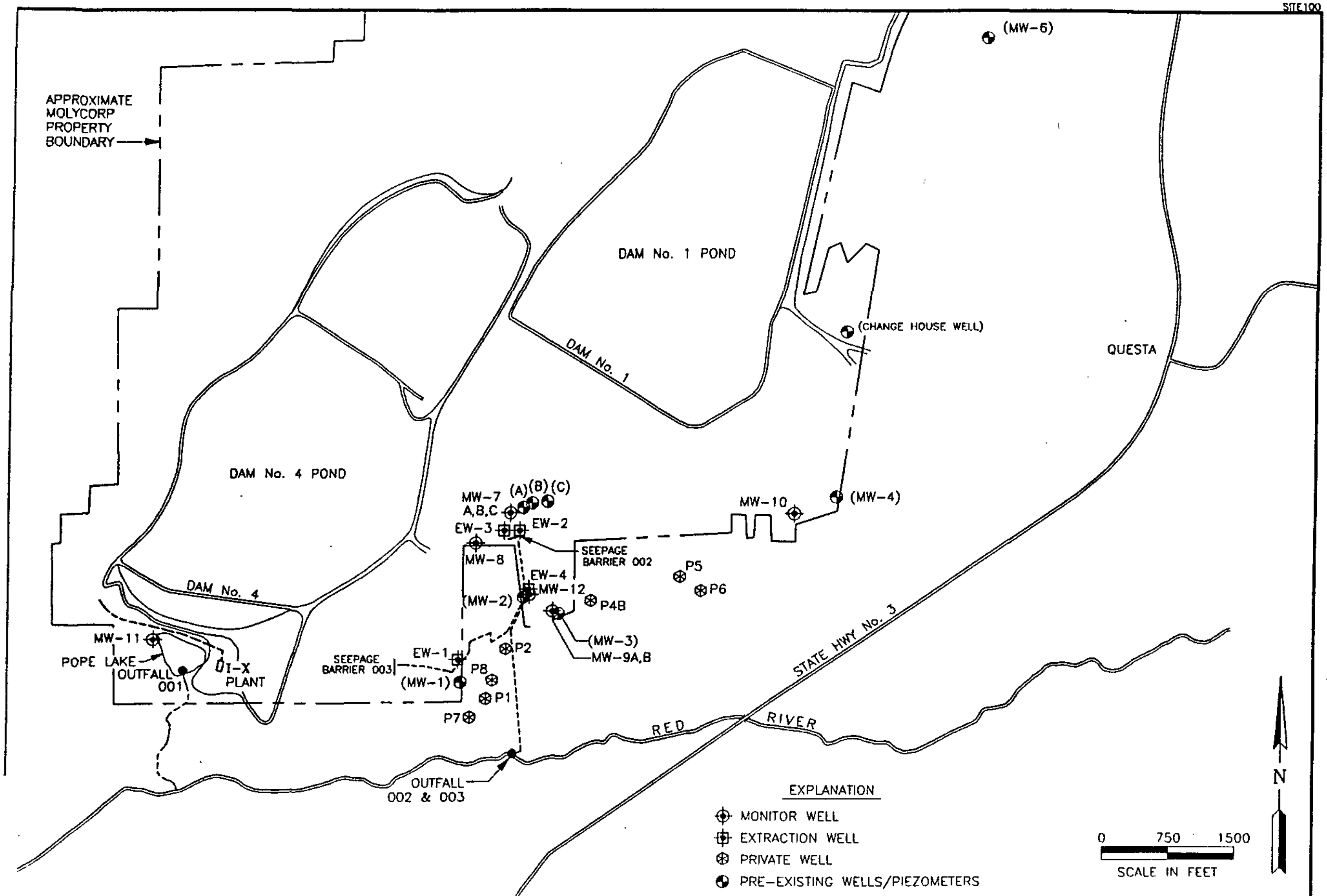

FIGURE: 2

SOUTH PASS RESOURCES, INC.

PROJECT No.:	DATE:	AUTHOR:	DRAWN BY:
001-06	3/31/95		M.O'M.

TAILINGS AREA SITE MAP
Molycorp, Inc.
Questa, New Mexico

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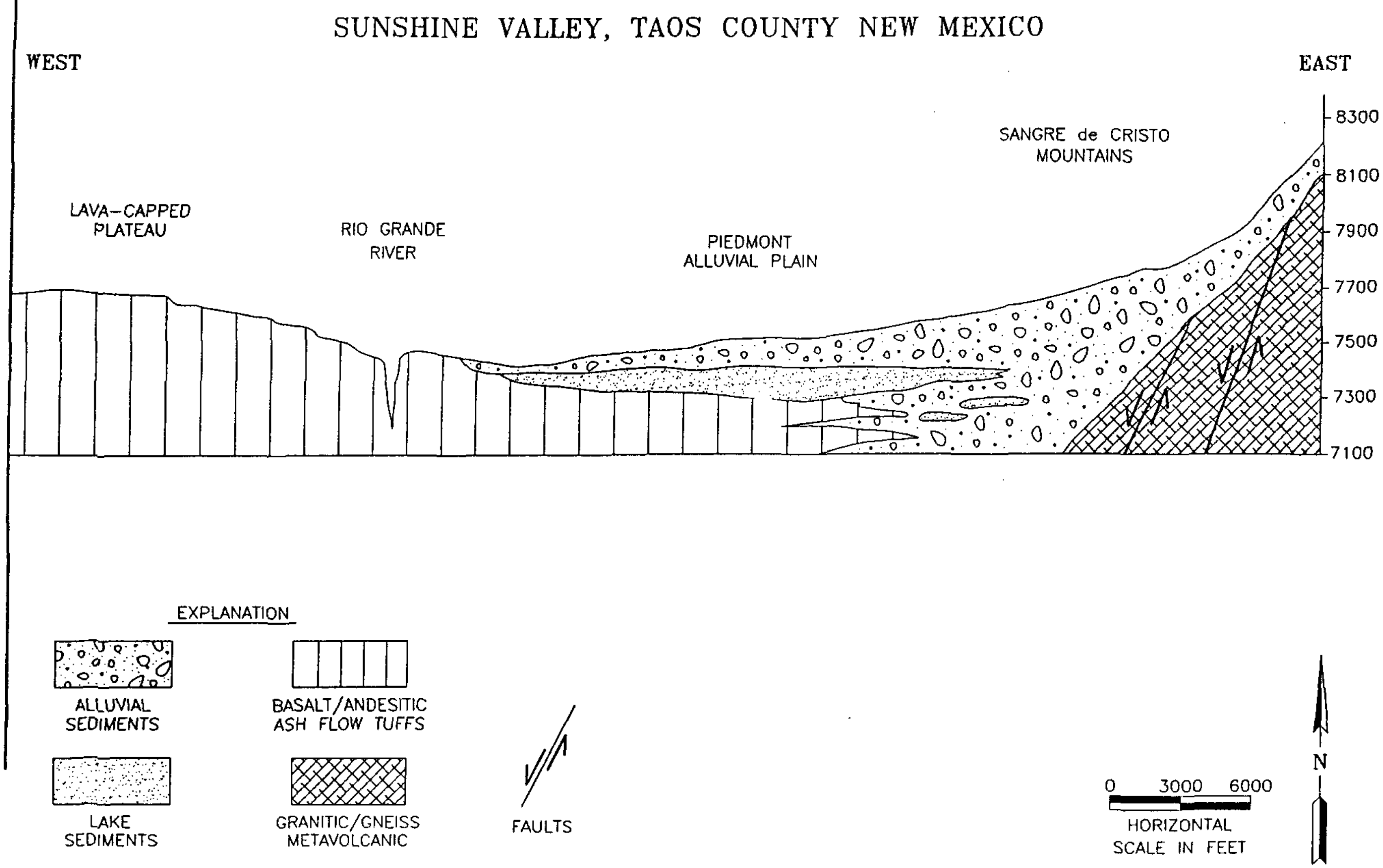

REFERENCE: MODIFIED FROM WINOGRAD, 1959.

FIGURE: 3	SOUTH PASS RESOURCES, Inc.				GENERALIZED GEOLOGIC CROSS-SECTION Molycorp , Inc. Questa, New Mexico
	PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.	

M-0000471

000421

XSEC-9

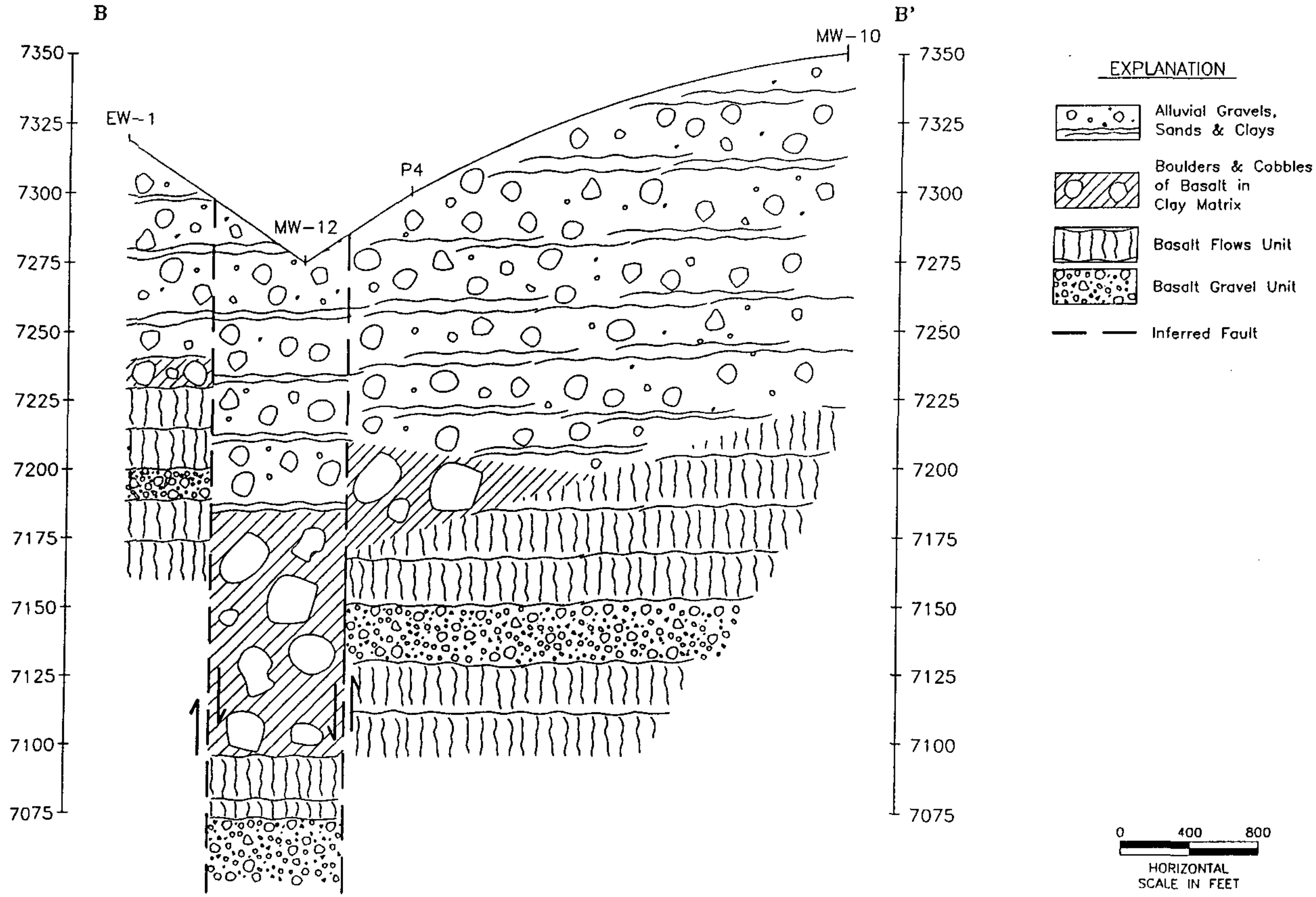

FIGURE: 4	SOUTH PASS RESOURCES, Inc.				GEOLOGIC CROSS-SECTION SOUTH OF DAM No. 1 Tailings Area – Molycorp, Inc. Questa, New Mexico
	PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.	

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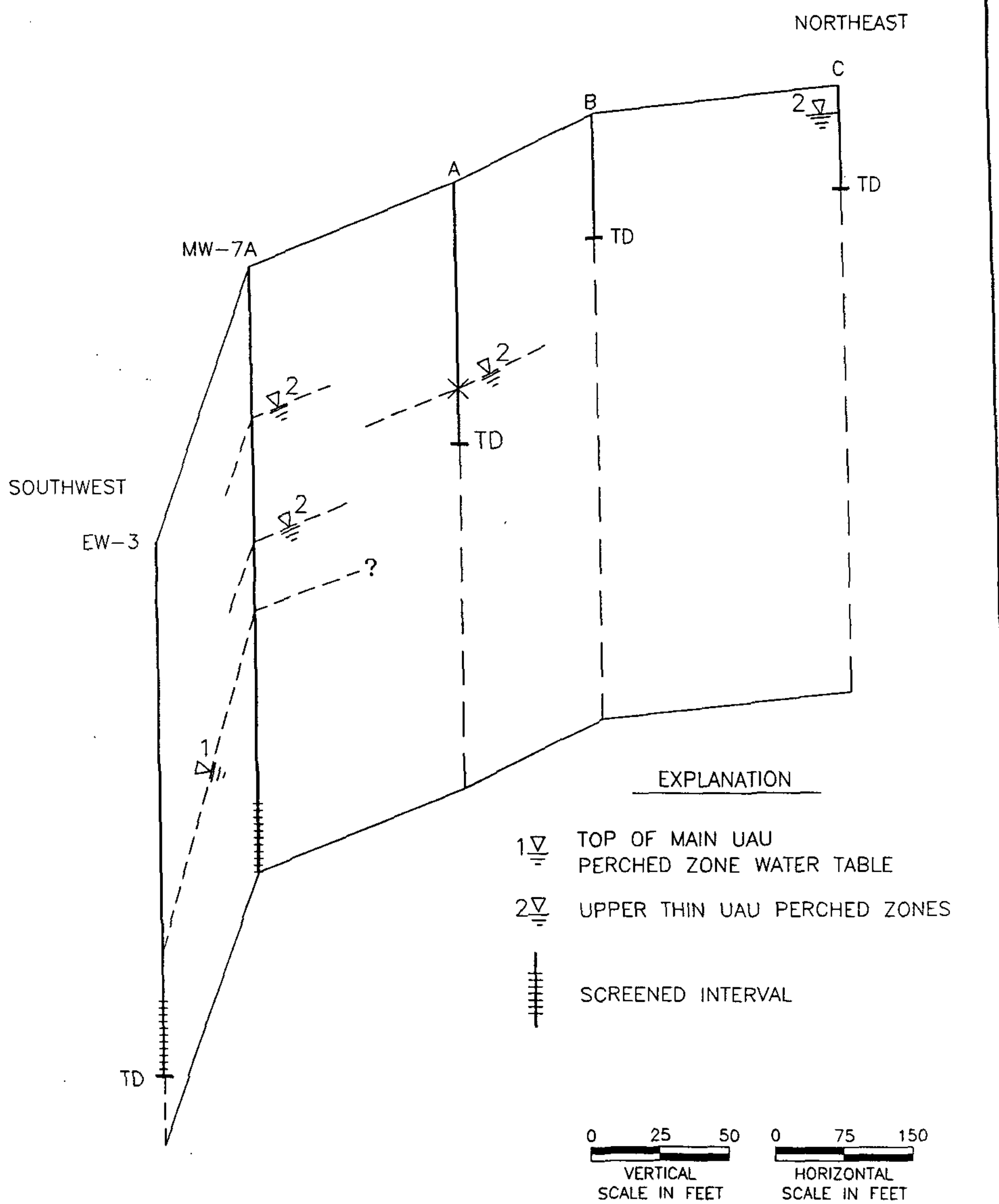

SOUTH PASS RESOURCES, Inc.				HYDROGEOLOGIC CROSS-SECTION SOUTH OF DAM No 1 – Tailings Area Molycorp, Inc., Questa, New Mexico	FIGURE: 5
PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.		

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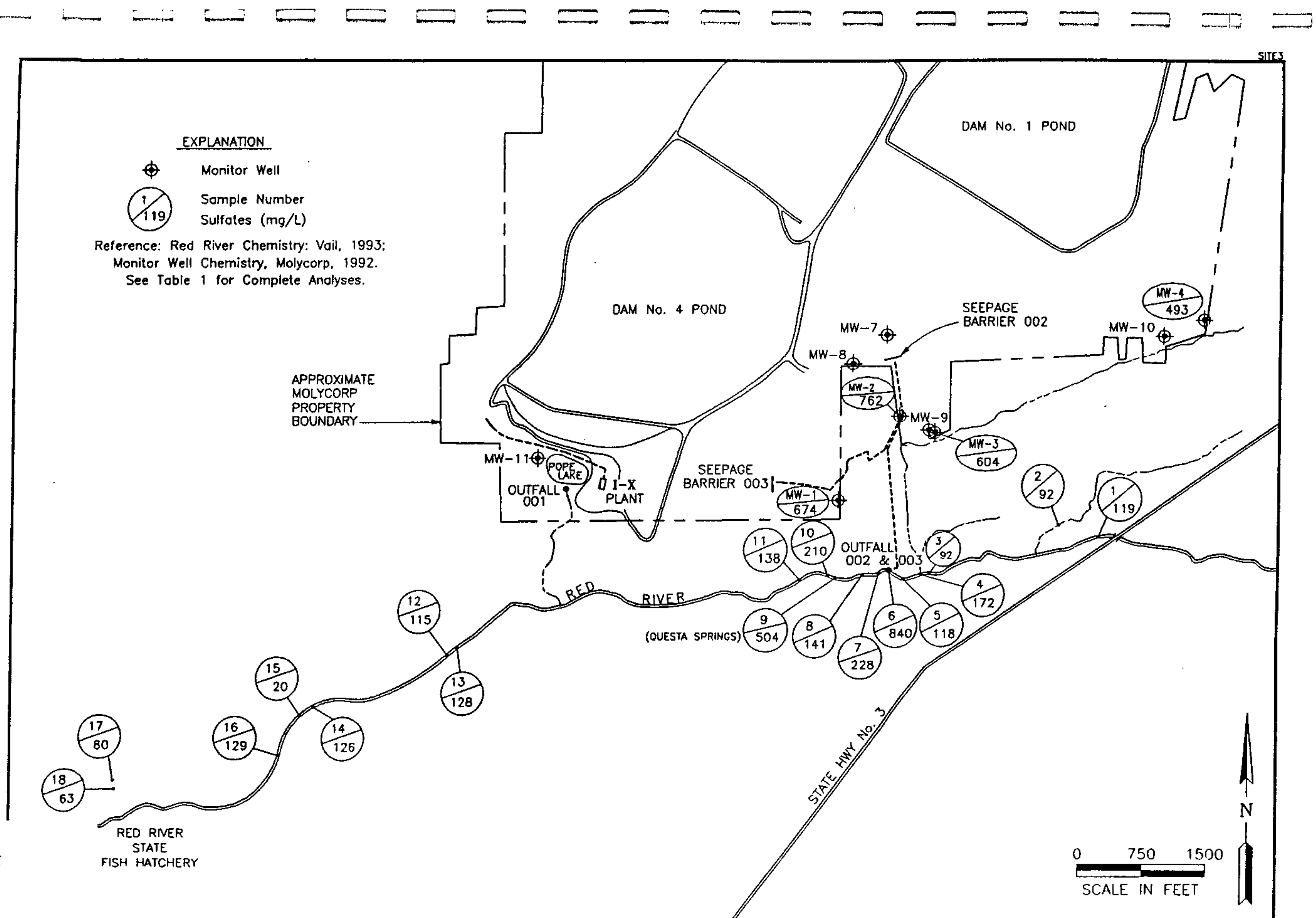

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FIGURE: 6

SOUTH PASS RESOURCES, Inc.				WATER QUALITY SURVEY: MONITOR WELLS & RED RIVER Tailings Area – Molycorp, Inc. Questa, New Mexico
PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.	

TABLE 1
1994 MONITOR WELL WATER QUALITY DATA FOR TAILINGS AREA
MOLYCORP, INC. - QUESTA, NEW MEXICO
(Page 1 of 3)

MONITOR WELL	SAMPLE DATE 1994	WELL TD (feet)	Corrected DEPTH TO WATER (feet)	DEPTH TO PUMP INTAKE (feet)	pH (1)	CONDUC-TIVITY (1) (uhmos)	TEMP (1) (°C)	CARBO -NATE (mg/L)	BICARBO -NATE (mg/L)	HYDR-OXIDE (mg/L)	TOTAL ALK (mg/L)	CHLORIDE (mg/L)	FLUORIDE (mg/L)	NITRATE (mg/L)	SUFATE (mg/L)
EW-1	7-Nov	157	83.00	102	7.50	1,460	NA	<1	156	<1	156	23	0.25	0.72	620
EW-2	8-Nov	204	147.91	170	7.48	850	12.9	<1	122	<1	122	4.8	0.49	0.2	96
EW-2	17-Nov	NA	NA	NA	NA	NA	NA	<1	118	<1	118	4.6	0.5	0.38	90
EW-3	8-Nov	78	57.74	70	7.48	1,135	11.4	<1	110	<1	110	17	0.16	0.6	440
EW-3	19-Nov	NA	NA	NA	NA	NA	NA	<1	136	<1	136	18	0.19	0.49	410
EW-4	7-Nov	58	18.49	50	7.78	650	11.6	<1	152	<1	152	26	0.21	0.35	150
EW-4	16-Nov	NA	NA	NA	NA	NA	NA	<1	156	<1	156	26	0.2	0.36	160
MW-1	7-Nov	100	53.17	80	7.28	1,322	NA	<1	136	<1	136	14	0.27	0.45	610
MW-2	7-Nov	80	22.07	60	7.96	1,701	NA	<1	80	<1	80	15	0.96	<0.06	860
MW-3	8-Nov	60	19.97	55	7.38	1,679	12.4	<1	183	<1	183	18	0.44	0.31	780
MW-4	8-Nov	96	40.77	65	7.61	1,157	12.3	<1	184	<1	184	7.3	0.73	0.24	460
MW-7A	7-Nov	90	58.84	80	7.50	1,565	11.9	<1	126	<1	126	16	0.18	0.72	730
MW-7C	9-Nov	146	111.79	135	7.10	2,160	12.4	<1	124	<1	124	16	0.17	0.32	790
MW-9A	8-Nov	44	26.30	35	7.32	1,021	13.1	<1	174	<1	174	20	0.44	0.33	680
MW-10	8-Nov	129	26.23	100	8.16	236	12.3	<1	77	<1	77	1.6	0.36	0.27	35
MW-11	9-Nov	249	191.93	210	7.00	440	19.8	<1	82	<1	82	10.3	1.28	0.39	58
MW-11AB	9-Nov	NA	NA	NA	NA	NA	NA	<1	79	<1	79	10.1	1.29	NA	58
MW-12	7-Nov	234	128.11	210	NA	NA	NA	<1	120	<1	120	5.1	0.46	NA	66
MW-A	7-Nov	38	30.58	NA	7.28	1,332	NA	<1	154	<1	154	14	0.35	0.37	560
MW-C	7-Nov	14.5	1.80	NA	7.24	1,902	NA	<1	185	<1	185	19	1.16	<0.06	970
CH	8-Nov	NA	NA	NA	7.97	539	13.5	<1	206	<1	206	2.3	0.71	0.44	75

NOTES:

(1) pH, CONDUCTIVITY AND TEMPERATURE WERE RECORDED WHEN SAMPLED.
SOURCE: SAMPLES TAKEN BY SPRI. ANALYTICAL RESULTS FROM MOLYCORP.

NA - NOT AVAILABLE

TABLE 1
1994 MONITOR WELL WATER QUALITY DATA FOR TAILINGS AREA
MOLYCORP, INC. - QUESTA, NEW MEXICO

(Page 2 of 3)

MONITOR WELL	TDS (mg/L)	SILVER (mg/L)	ALUMINUM (mg/L)	ARSENIC (mg/L)	BARIUM (mg/L)	BERYLLIUM (mg/L)	CALCIUM (mg/L)	CADMIUM (mg/L)	COBALT (mg/L)	CHROMIUM (mg/L)	COPPER (mg/L)	IRON (mg/L)	MERCURY (mg/L)
EW-1	1,200	<0.10	<0.05	<0.005	0.053	<0.004	240	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
EW-2	240	<0.10	<0.05	<0.005	0.068	<0.004	59.4	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
EW-2	290	<0.010	<0.05	<0.005	0.065	<0.004	57.8	0.0036	<0.010	<0.010	<0.010	<0.050	<0.0002
EW-3	830	<0.10	<0.05	<0.005	0.074	<0.004	179	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
EW-3	750	<0.010	<0.05	<0.005	0.054	<0.004	158	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
EW-4	440	<0.10	<0.05	<0.005	0.065	<0.004	101	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
EW-4	450	<0.010	<0.05	<0.005	0.068	<0.004	104	<0.0005	<0.010	<0.010	0.012	<0.050	<0.0002
MW-1	1,100	<0.10	<0.05	<0.005	0.025	<0.004	207	<0.0005	<0.010	<0.010	<0.010	0.068	<0.0002
MW-2	1,400	<0.10	<0.05	<0.005	0.022	<0.004	241	<0.0005	<0.010	<0.010	<0.010	4.6	<0.0002
MW-3	1,400	<0.10	<0.05	<0.005	0.032	<0.004	264	<0.0005	<0.010	<0.010	<0.010	0.07	<0.0002
MW-4	890	<0.10	<0.05	<0.005	0.084	<0.004	166	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-7A	1,300	<0.10	<0.05	<0.005	0.028	<0.004	273	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-7C	1,300	<0.10	<0.05	<0.005	0.028	<0.004	279	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-9A	1,200	<0.10	<0.05	<0.005	0.061	<0.004	247	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-10	150	<0.10	<0.05	<0.005	0.038	<0.004	28.2	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-11	200	<0.10	<0.05	<0.005	0.014	<0.004	28.6	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-11AB	220	<0.10	<0.05	<0.005	0.015	<0.004	28.5	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-12	260	<0.10	<0.05	<0.005	0.096	<0.004	47.1	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-A	1,000	<0.10	<0.05	<0.005	0.03	<0.004	214	<0.0005	<0.010	<0.010	<0.010	0.066	<0.0002
MW-C	1,700	<0.10	<0.05	<0.005	0.04	<0.004	334	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
CH	340	<0.10	<0.05	<0.005	0.059	<0.004	48.5	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002

NOTES:

(1) pH, CONDUCTIVITY AND TEMPERATURE WERE RECORDED WHEN SAMPLED.

SOURCE: SAMPLES TAKEN BY SPRI. ANALYTICAL RESULTS FROM MOLYCORP.

NA - NOT AVAILABLE

TABLE 1
1994 MONITOR WELL WATER QUALITY DATA FOR TAILINGS AREA
MOLYCORP, INC. - QUESTA, NEW MEXICO

MONITOR WELL	POTASSIUM (mg/L)	MAGNESIUM (mg/L)	MANGANESE (mg/L)	MOLYBDENUM (mg/L)	SODIUM (mg/L)	NICKEL (mg/L)	LEAD (mg/L)	ANTIMONY (mg/L)	SELENIUM (mg/L)	SILICON (mg/L)	THALLIUM (mg/L)	VANADIUM (mg/L)	ZINC (mg/L)
EW-1	3.7	47.9	0.017	<0.02	41.7	<0.020	<0.002	<0.05	<0.005	13.8	<0.005	<0.010	<0.050
EW-2	3.3	10.4	0.169	<0.02	20.0	<0.020	<0.002	<0.05	<0.005	15.7	<0.005	<0.010	<0.050
EW-2	3.6	10	0.138	<0.02	19.6	<0.020	<0.002	<0.05	<0.005	17.3	<0.005	<0.010	0.091
EW-3	2.6	31.8	0.056	<0.02	28.6	<0.020	<0.002	<0.05	<0.005	12.4	<0.005	<0.010	<0.050
EW-3	2.2	27.8	0.036	<0.02	28.9	<0.020	<0.002	<0.05	<0.005	11.9	<0.005	<0.010	0.364
EW-4	1.5	17.8	<0.010	<0.02	15.5	<0.020	<0.002	<0.05	<0.005	12.4	<0.005	<0.010	<0.050
EW-4	2.1	18.1	0.019	<0.02	16	<0.020	<0.002	<0.05	<0.005	12.7	<0.005	<0.010	0.364
MW-1	3.0	41.2	0.035	0.04	55.4	<0.020	<0.002	<0.05	<0.005	11.9	<0.005	<0.010	<0.050
MW-2	3.1	52.2	0.37	1.7	95.6	<0.020	<0.002	<0.05	<0.005	1.8	<0.005	<0.010	<0.050
MW-3	1.5	48.6	0.032	<0.02	71.6	<0.020	<0.002	<0.05	<0.005	10.3	<0.005	<0.010	<0.050
MW-4	1.1	32.7	<0.010	0.21	64.2	<0.020	<0.002	<0.05	<0.005	10.3	<0.005	<0.010	<0.050
MW-7A	2.6	47.1	<0.010	<0.02	39.5	<0.020	<0.002	<0.05	<0.005	12.3	<0.005	<0.010	<0.050
MW-7C	3.9	48.4	<0.010	<0.02	45.1	<0.020	<0.002	<0.05	<0.005	12.1	<0.005	<0.010	<0.050
MW-9A	1.7	45.5	0.111	<0.02	66.0	<0.020	<0.002	<0.05	<0.005	10.5	<0.005	<0.010	<0.050
MW-10	1.3	4.4	<0.010	<0.02	14.7	<0.020	<0.002	<0.05	<0.010	10.8	<0.005	<0.010	<0.050
MW-11	2.8	8.6	<0.010	0.06	25.8	<0.020	<0.002	<0.05	<0.005	15.5	<0.005	<0.010	<0.050
MW-11AB	2.6	8.6	<0.010	0.06	25.7	<0.020	<0.002	<0.05	<0.005	15.5	<0.005	0.01	<0.050
MW-12	2.9	8.5	<0.010	0.02	24.5	<0.020	<0.002	<0.05	<0.005	13.6	<0.005	<0.010	<0.050
MW-A	2.8	35.7	0.04	0.63	50.6	<0.020	<0.002	<0.05	<0.005	10.9	<0.005	<0.010	<0.050
MW-C	2.1	56.1	0.774	1.12	82.2	<0.020	<0.002	<0.05	<0.005	11.6	<0.005	<0.010	<0.050
CH	1.2	9.4	<0.010	<0.02	57.8	<0.020	<0.002	<0.05	<0.005	9.8	<0.005	<0.010	0.946

NOTES:

(1) pH, CONDUCTIVITY AND TEMPERATURE WERE RECORDED WHEN SAMPLED.

SOURCE: SAMPLES TAKEN BY SPRI. ANALYTICAL RESULTS FROM MOLYCORP.

NA - NOT AVAILABLE

TABLE 2
HISTORICAL WATER QUALITY DATA FOR PRIVATE WELLS
TAILINGS AREA - MOLYCORP, INC. - QUESTA, NEW MEXICO

Well #	P-1	P-2	P-3	P-4A	P-4B	P-5	P-6	P-7	P-8	P-9
DATE	1988	1979	1979	1987	1993	1993	1987	1975	1987	1993
Bicarbonate Alkalinity (mg/L)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbonate Alkalinity (mg/L)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hydroxide Alkalinity (mg/L)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum (mg/L)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic (mg/L)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium (mg/L)	<0.01	NA	NA	<0.01	<0.005	<0.005	<0.1	NA	<0.001	<0.005
Calcium (mg/L)	246	NA	NA	128	NA	NA	37	NA	212	NA
Chlorine (mg/L)	21	NA	NA	NA	NA	NA	<5.0	NA	18	NA
Chromium (mg/L)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper (mg/L)	<0.01	NA	NA	0.005	0.01	<0.01	NA	NA	<0.1	0.01
Fluoride (mg/L)	0.40	0.50	0.50	NA	0.45	0.42	NA	NA	NA	0.7
Iron (mg/L)	<0.05	0.39	0.13	0.1	<0.05	0.08	<0.1	0.07	<0.1	0.12
Lead (mg/L)	<0.05	NA	NA	<0.05	<0.1	<0.10	<0.1	NA	<0.01	<0.1
Magnesium (mg/L)	39	NA	NA	17	NA	NA	3.0	NA	22	NA
Manganese (mg/L)	0.01	0.03	0.02	NA	<0.01	<0.01	<0.05	NA	<0.05	0.143
Molybdenum (mg/L	0.07	0.02	NA	0.01	<0.005	<0.005	<0.1	2.27	<0.1	<0.005
Potassium (mg/L)	3.0	NA	NA	1.0	NA	NA	4.0	NA	2.0	NA
Redox Pot. (mg/L)	NA	NA	NA	27	NA	NA	NA	NA	NA	NA
Sodium (mg/L)	58	NA	NA	79	NA	NA	9.0	NA	41	NA
Sulfate (mg/L)	763	228	44	358	97	112	32	NA	504	94
TDS (mg/L)	1376	619	345	772	398	276	186	NA	982	270
Zinc (mg/L)	0.08	2.45	0.01	0.64	0.89	0.21	<0.1	NA	<0.1	0.08
pH	7.8	7.4	7.7	7.0	7.5	7.7	7.7	NA	7.1	7.3

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KEY TO TABLE 3
LOCATIONS OF WATER SAMPLES
TAILINGS AREA - MOLYCORP, INC. - QUESTA NEW MEXICO

#1	Red River below Highway 38 bridge.
#2	Spring on north side of Red River
#3	Field Drainage to Red River, 500 feet east of Outfall 002
#4	Field Drainage to Red River, 450 feet east of Outfall 002
#5	Red River 300 feet east of Outfall 002
#6	Outfall No. 002
#7	Field Drainage 75 feet west of Outfall 002
#8	Red River above Questa Springs
#9	Near Questa Springs, southeast of concrete box
#10	Near Questa Springs, end of old pipe
#11	Red River 500 feet west of Questa Springs
#12	Spring, north side of Red River Station 47+20
#13	Red River Station 47+70, above Hatchery
#14	Spring south side of Red River Station 36+80
#15	Spring north side of Red River Station 36+40
#16	Red River
#17	Hatchery; cold water inlet
#18	Hatchery; warm water inlet

TABLE 3
WATER QUALITY DATA FOR THE RED RIVER (VAIL ENG., 1993)
TAILINGS AREA - MOLYCORP, INC. - QUESTA, NEW MEXICO
(Page 1 of 2)

Sample Location Number	#1	#2	#3	#4	#5	#6	#7	#8	#9
Total Alkalinity (mg/L)	38	90	99	94	43	152	165	50	158
Dissolved Aluminum (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Suspended Aluminum (mg/L)	7.8	0.50	<0.50	<0.50	8.0	<0.5	2.7	6.2	8.5
Cadmium (mg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper (mg/L)	0.036	0.007	<0.005	0.008	0.028	<0.005	0.009	0.029	0.016
Fluoride (mg/L)	0.84	0.55	0.60	0.46	0.90	1.90	0.80	0.88	0.38
Iron (mg/L)	0.594	0.543	0.405	0.115	0.569	0.102	1.09	0.573	2.94
Lead (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Manganese (mg/L)	0.92	0.02	0.05	0.05	0.88	1.40	0.03	0.88	0.07
Molybdenum (mg/L)	<0.03	<0.03	0.20	<0.03	<0.03	1.80	0.20	<0.03	<0.03
Total Dissolved Solids (mg/L)	255	247	246	648	240	1764	727	268	1094
Total Suspended Solids (mg/L)	31	20	7.0	6.0	22	2.0	39	21	88
Sulfate (mg/L)	119	92	92	172	118	840	228	141	504
Zinc (mg/L)	0.250	0.021	0.047	0.012	0.222	0.010	0.017	0.207	0.047
Temprature (°C)	8.3	10.5	11.2	17.8	9.1	9.7	10.1	9.8	7.8
pH	7.23	6.76	7.44	8.22	7.60	7.26	7.20	7.14	7.02

SOURCE: Vail Engineering (Ralph Vail).
NA - Not Available

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TABLE 3
WATER QUALITY DATA FOR THE RED RIVER (VAIL ENG., 1993)
TAILINGS AREA - MOLYCORP, INC. - QUESTA, NEW MEXICO
(Page 2 of 2)

Sample Location Number	#10	#11	#12	#13	#14	#15	#16	#17	#18
Total Alkalinity (mg/L)	177	54	82	51	82	80	49	43	77
Dissolved Aluminum (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Suspended Aluminum (mg/L)	<0.5	3.1	1.7	3.0	<0.50	<0.50	3.1	<0.50	<0.50
Cadmium (mg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper (mg/L)	0.005	0.033	0.011	0.026	<0.005	<0.005	0.024	<0.005	<0.005
Fluoride (mg/L)	0.60	0.90	0.80	0.90	0.80	1.10	0.90	0.64	0.54
Iron (mg/L)	<0.05	0.618	2.36	0.590	<0.05	<0.05	0.527	0.138	0.181
Lead (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Manganese (mg/L)	0.01	0.88	0.13	0.83	0.01	NA	0.781	NA	NA
Molybdenum (mg/L)	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Total Dissolved Solids (mg/L)	576	269	271	259	304	145	247	176	284
Total Suspended Solids (mg/L)	7.0	22	47	22	<1.0	<1.0	24	NA	NA
Sulfate (mg/L)	210	138	115	128	126	20	129	80	63
Zinc (mg/L)	0.010	0.215	0.046	0.206	0.005	<0.005	0.191	<0.005	0.010
Temprature (°C)	7.1	10.3	15.3	10.5	16.9	16.4	11	8.3	15.8
pH	7.50	7.45	6.94	7.45	8.14	7.26	7.8	7.14	7.87

SOURCE: Vail Engineering (Ralph Vail).
NA - Not Available

APPENDIX A

Detail Of Tailings Area Site Geology

APPENDIX A

Detail Of Tailings Area Site Geology

TABLE OF CONTENTS

Page

A.1 STRATIGRAPHY 1
A.2 SANTA FE GROUP 1
A.3 VOLCANIC UNITS 3
A.4 GEOLOGIC STRUCTURE 3

LIST OF FIGURES

Figure A1: Geologic Map -- Tailings Area
Figure A2: Geologic Cross-Section A-A'
Figure A3: Geologic Cross-Section B-B' South of Dam No. 1

APPENDIX A

Detail of Tailings Area Site Geology

A.1 STRATIGRAPHY

The stratigraphic sequence in the vicinity of the tailings ponds was identified based on 14 borehole lithologic logs, 3 geophysical logs, field reconnaissance, and unpublished geologic maps (Vail, 1987; Molycorp files) of the area. Much of the Tailings Area is immediately underlain by gravel, sand, and clay [assigned by Winograd (1959) to the Santa Fe Group]. Recent alluvial sediments appear to be confined to the bottom of the arroyos and are on the order of 20 feet or less in thickness (Dames and Moore, 1965, cross-section). A thin, distinctive sequence of coarse volcanic sand and volcanic conglomerate crops out along the southwest side of Dam No. 4 and appears in the top 29 feet of monitor well MW-11 in the same area. The stratigraphic relationship of this unit to the sedimentary beds elsewhere on the site is unresolved.

Borehole data show that a basalt/andesite unit (hereafter referred to as *basalt*) underlies the alluvial deposits of the Santa Fe Group from west to east across the site. A thin basalt gravel is interlayered with the basalt and is a distinct marker horizon in the wells that penetrate deeply enough in the volcanic unit. Volcanics along the eastern edge of the Guadalupe Mountains consist in part of ash flow tuffs and appear to be in fault contact with the basalts and the alluvial deposits of the Santa Fe Group. It is not known at this time whether these basalt flows are equivalent to the Servilleta Basalt or one of the older Miocene flow units. Ash flow tuffs are more typical of the Late-Oligocene to Mid-Miocene volcanics (Molycorp, unpublished data) and may be older than the basalt/alluvial units in the tailings area.

A.2 SANTA FE GROUP

Based on the SPRI geophysical and borehole logs [Fall 1994 investigation (Appendix C) and previous field work], the alluvial deposits of the Santa Fe Group in the Tailings Area consists of:

- an Upper Aquifer Unit (UAU) composed of brown sandy gravels and gravelly sands with a subordinate component of pale red brown silty, sandy clay.
- a Middle Aquitard Unit (MAU) in which pale red brown clay and gravelly clay are the dominant sediments.

- a Lower Aquifer Unit (LAU) composed of sandy or clayey gravel. Thin beds of tightly cemented sandstone were noted in MW-7 and MW-10.

- a Basal Aquitard Unit (BAU) is a bouldery clay that is restricted to a few deep boreholes south of Dam No. 1.

[NOTE: These four lithologic divisions are based on dominant textural characteristics, but each unit contains subordinate amounts of the other lithologies (for example: clay beds occur within the UAU and LAU). There are no marker beds to establish lateral equivalence between borehole sections, such that parts of the MAU may be temporally equivalent to the lower part of the UAU, or the upper part of the LAU. In general, the internal structure of a sequence of alluvial or alluvial/lacustrine (lake) sediments is expected to be lensoid in character and to have sand and gravel lenses intertongueing with clay-rich units (Galloway and Hobday, 1983).]

East of Dam No. 1 (in the direction of the Sangre de Cristo Mountains), the Santa Fe Group coarsens and thickens. As evidence, the Change House Well (located east of Dam No. 1) bottoms at a depth of 250 feet in gravel, and the Questa Well No. 2 (north of the Town of Questa) bottoms at 500 feet in gravel.

In surface outcrops in the Tailings Area, gravels range from very fine gravel (0.08 to 0.16 inch) to cobble sizes (2.4 to 10.24 inches), but most of the material appears to be below cobble size. Geotechnical drilling for Dam No. 1 (Molycorp files: pre-dam cross-section along the proposed axis of Dam No. 1) and the borehole log for the Change House Well (east of Dam No. 1) indicate that boulder-size material is present in the UAU and LAU. Drilling conditions in the lower LAU at EW-2 and MW-12 also were indicative of boulder layers within the alluvial unit. Clast composition in the gravels (with the exception of the LAU in some boreholes) seems to largely reflect sources in the Sangre de Cristo Mountains to the east. A variety of volcanic rock types (flows, ash flow tuffs), intrusive igneous rocks (pegmatite, granite, quartz monzonite), and metamorphic rocks (gneisses) occur in the gravels.

The bouldery clay deposit is a basalt boulder/cobble unit below the LAU that contains an abundance of clay/silt in the matrix (20 to 40 percent clay matrix). Thin intervals of basaltic sandy gravels and gravelly sands occur within this unit. The unit appears to be thickest in EW-2 and MW-12 (which were drilled south of Dam No. 1), but thins abruptly to the west (less than 10 feet thick at EW-1) and appears to thin more gradually to the east (log for P-4B suggests 30 to 40 feet). Farther east, at MW-10, this unit is not present. The boulder clay unit is interpreted to be a mudflow deposit containing scattered channel gravels. The deposit is analogous to basalt mud flow deposits exposed along the current Rio Grande Gorge south of Taos. The bouldery clay unit functions as an aquitard.

A thin sequence of brown, silty, highly burrowed sands, black coarsely grained volcanic sands, and gravelly clayey volcanic sands crop out in the vicinity of MW-11. The gravels in this unit are entirely composed of volcanic clasts. Similar sediments were penetrated in the upper 29 feet of MW-11 and in several borings near the toe of Dam No. 4. This unit is shown separately (as T_{svs}) on the geologic map (Figure A1). It may be equivalent to the basaltic mudflow deposit below the LAU.

A.3 VOLCANIC UNITS

Lithologic information for the volcanic rocks penetrated by the monitor wells in the Tailings Area comes primarily from descriptions of borehole cuttings (Appendix C). The flow rock is a finely crystalline olivine basalt or andesite containing brown millimeter-size phenocrysts of altered olivine and of pyroxene. White phenocrysts of feldspar were also noted. A few cuttings showed glassy textures which probably indicate the tops or bases of individual flows. Both vesicular, and to a greater extent, non-vesicular basalt are present. Flow banding was observed in some cuttings. White and pale blue quartz/chalcedony fills some vesicules and occurs along a few fractures. For the purpose of this report, this unit will be referred to as basalt. Thin volcanic breccias consisting of black to gray angular volcanic fragments in a red volcanic matrix are interlayered with the flows. Exposures of the basalt along the walls of Pope Wash, south of MW-11, show that the basalt is highly fractured with sets of vertical fractures coupled with units showing a distinct horizontal parting. (Volcanics observed along the east side of the Guadalupe Mountains were examined during a half-day reconnaissance of the area. These are dominantly medium gray ash flow tuffs characterized by flattened brown to tan pumice fragments and by the presence of black basal vitrophyres.)

A.4 GEOLOGIC STRUCTURE

Reconnaissance mapping, combined with a description of the subsurface geology based on borehole data, indicate the presence of five northeast-trending faults that displace the Santa Fe Group alluvial sediments relative to various volcanic units in the tailings area (see Figures A1, A2, and A3). The apparent sense of movement along all of the faults is based on stratigraphic displacements. Because this Mid-Tertiary faulting was associated with rifting of the Rio Grande Basin, vertical displacements would be expected. However, lateral (including oblique) displacements also occur within the rift system.

Vail (unpublished geologic map, 1987) mapped a northeast-trending high-angle fault along the east flank of the Guadalupe Mountains. This fault appears to follow the west side of a linear, northeast-trending wash, now largely covered by the tailings behind Dam No. 4. The ash flow tuffs along the east flank of the mountain are moderately tilted along the fault line and, in places, unconformably overlain by Santa Fe Group or younger gravels. The Santa Fe volcanic sediments and the basalt unit south of Dam No. 4 lie east of the fault and appear to be truncated by the structure. The ash flow tuffs may correlate with volcanics that are either the same age as the lower Santa Fe or older than the Santa Fe. This condition suggests that the fault block to the east has moved relatively downward.

In the Work Plan for the tailings pond facility study (SPRI, 1993), the linear, northeast-trending pattern of the ridge between Dam No. 1 and Dam No. 4 and of the wash to the east of the ridge was identified. The wash between MW-1 and MW-2 was postulated to follow a high-angle fault because of the apparent displacement of the volcanic unit in MW-1 relative to the sediments (at the same elevation) in MW-2 (Figure A2) and because of the linearity of the wash. Wells MW-8 and MW-7, drilled 1,500 feet to the north of MW-1 and MW-2, show a similar structural relationship confirming a linear structure extending northeast along the wash. The volcanics were not encountered in MW-9, drilled to elevations that are well below the level of the volcanics in MW-1. However, the volcanic unit does appear at deeper levels farther east in the lower part of private well P-4B and MW-10.

Cross-sections (Figure A2) indicate that a postulated northeast-trending fault may also extend beneath the ridge that divides Dam No. 1 and Dam No. 4. This structure is based on the difference in elevation between the basalt outcrop immediately east of the I-X building and the top of the volcanic unit in MW-1 (a difference of 157 feet), and the linearity of the ridge. However, at the I-X outcrop, Santa Fe gravels unconformably overlie the basalt, and the basalt ridge could be an erosional feature.

The volcanic sediments outcropping below Dam No. 4 and noted in several boreholes appear to be truncated by the basalt unit unconformably overlain by the Santa Fe Group immediately east of the I-X building. The volcanic sediments (T_{svs} on Figure A1) were not observed in the exposures of the Santa Fe Group east of the I-X building. The apparent truncation of the stratigraphic units and the absence of the volcanic sediments are the basis for the fault shown east of the I-X building on the geologic map.

Given that both the outpouring of basalt flows and the deposition of the basin sediments occurred during the Rio Grande rifting, it is probable that the present stratigraphic and structural relationships are the result of a combination of faulting and contemporaneous erosional/sedimentation. The localized occurrence of the basaltic boulder clay south of Dam No. 1 suggests the possibility of mudflows contemporaneous with the development of fault topography. The maximum apparent displacement of the top of the basalt gravel between EW-1 and MW-12 is 125 feet. At this point, it is not known how much of this apparent displacement is tectonic and how much is erosional.

Both the borehole locations and the field exposures are in a narrow band along the front of Dam No. 1 and Dam No. 4. The geologic structure and the lithologic units, particularly the basalt unit, are believed to extend northward beneath the tailings ponds and southward at least to the Red River. Of geologic significance are:

1) the extension of the basalt unit in an east-west direction entirely beneath the tailings ponds is at fairly shallow depths;

2) a mudflow aquitard is present immediately above the regional volcanic aquifer south of Dam No. 1; and

3) the northeast-trending fault structures resulted in juxtaposed stratigraphic units that have different hydrogeological properties (for example: clay in fault contact with fractured basalt). These relationships can result in barriers to the regional flow systems.

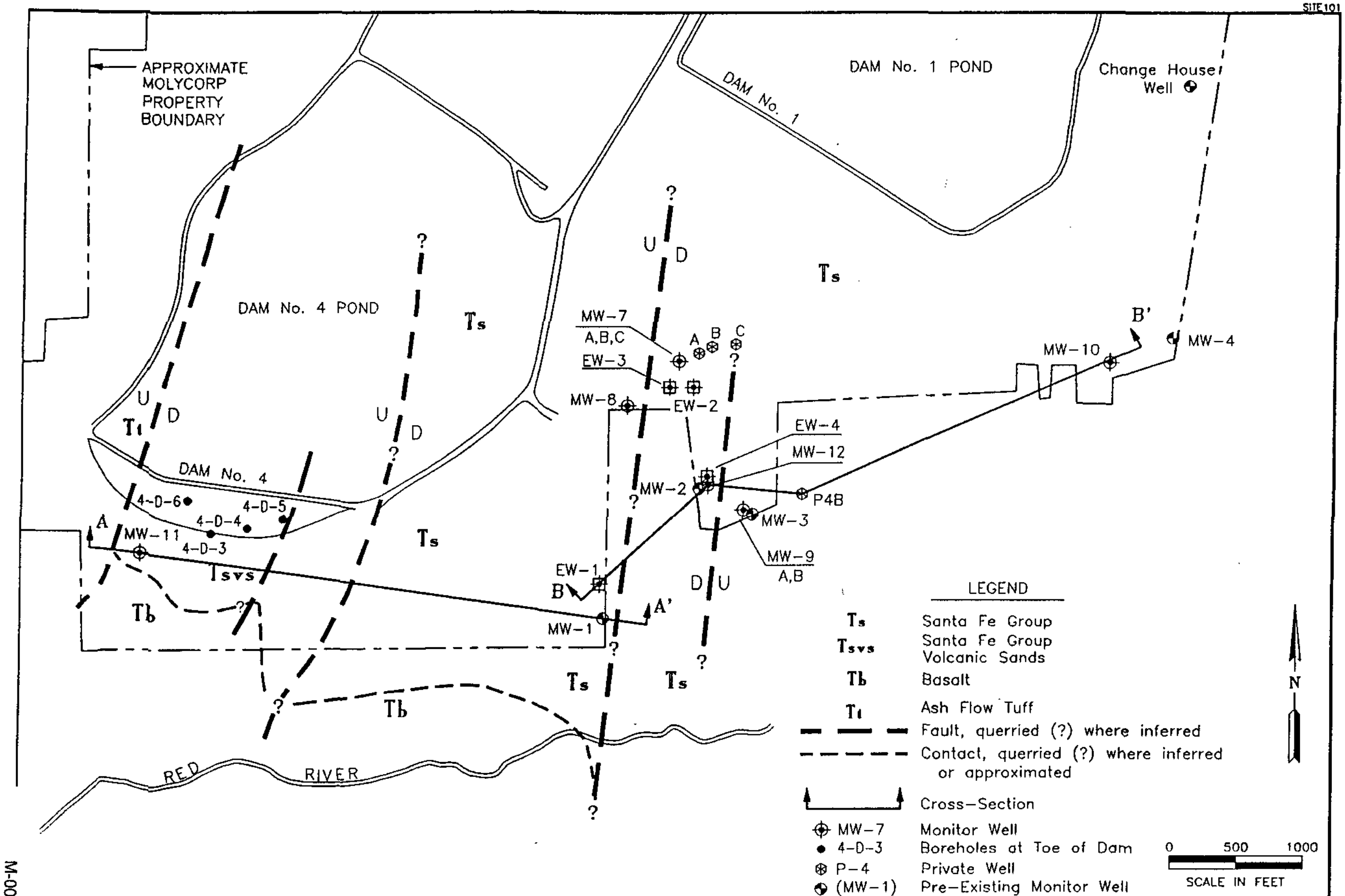

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FIGURE: A1	SOUTH PASS RESOURCES, Inc.			
	PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.

GEOLOGIC MAP – TAILINGS AREA
Molycorp, Inc.
Questa, New Mexico

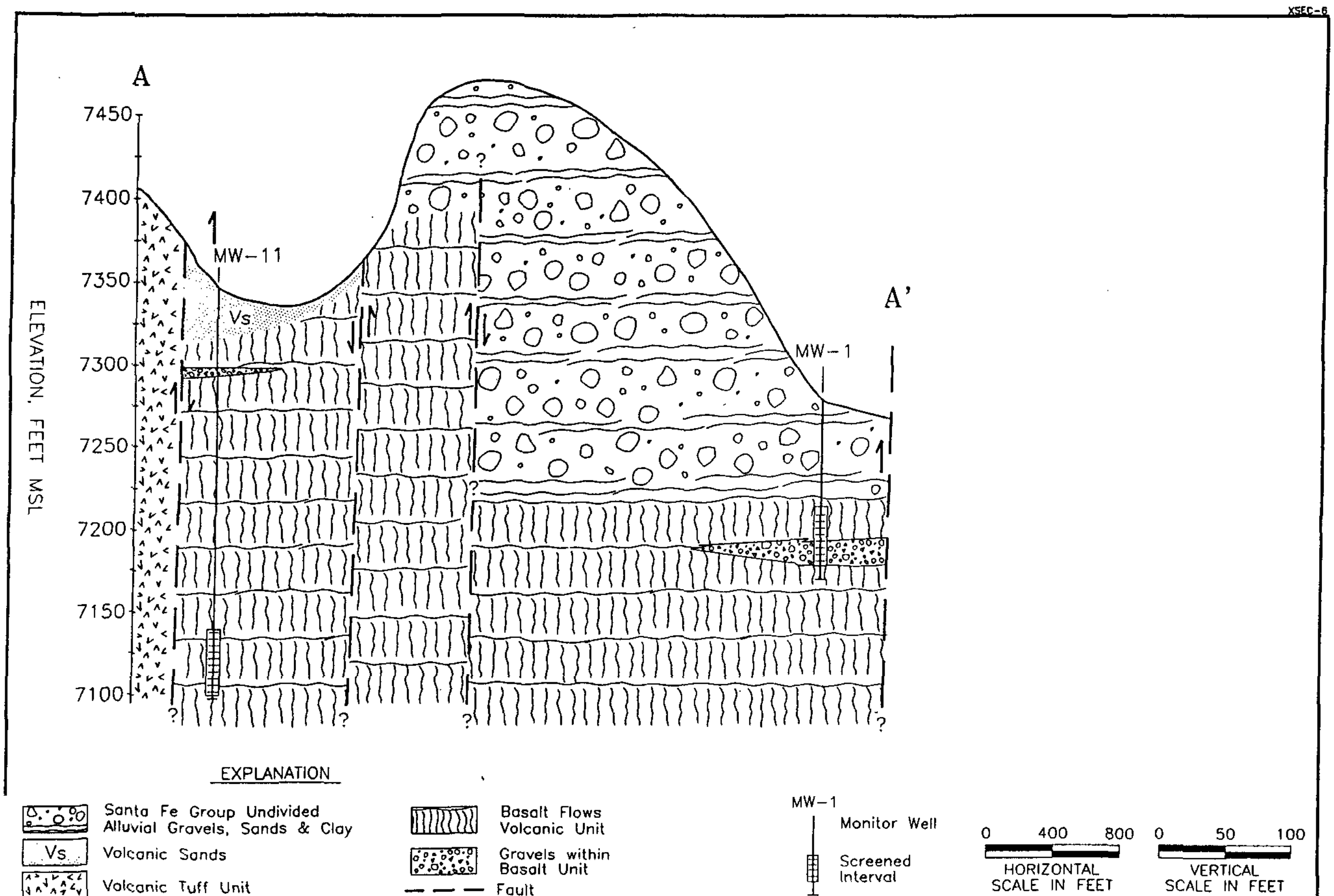

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FIGURE: A2	SOUTH PASS RESOURCES, Inc.				GEOLOGIC CROSS-SECTION A – A' Tailings Area – Molycorp, Inc. Questa, New Mexico
	PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.	

XSEC-9

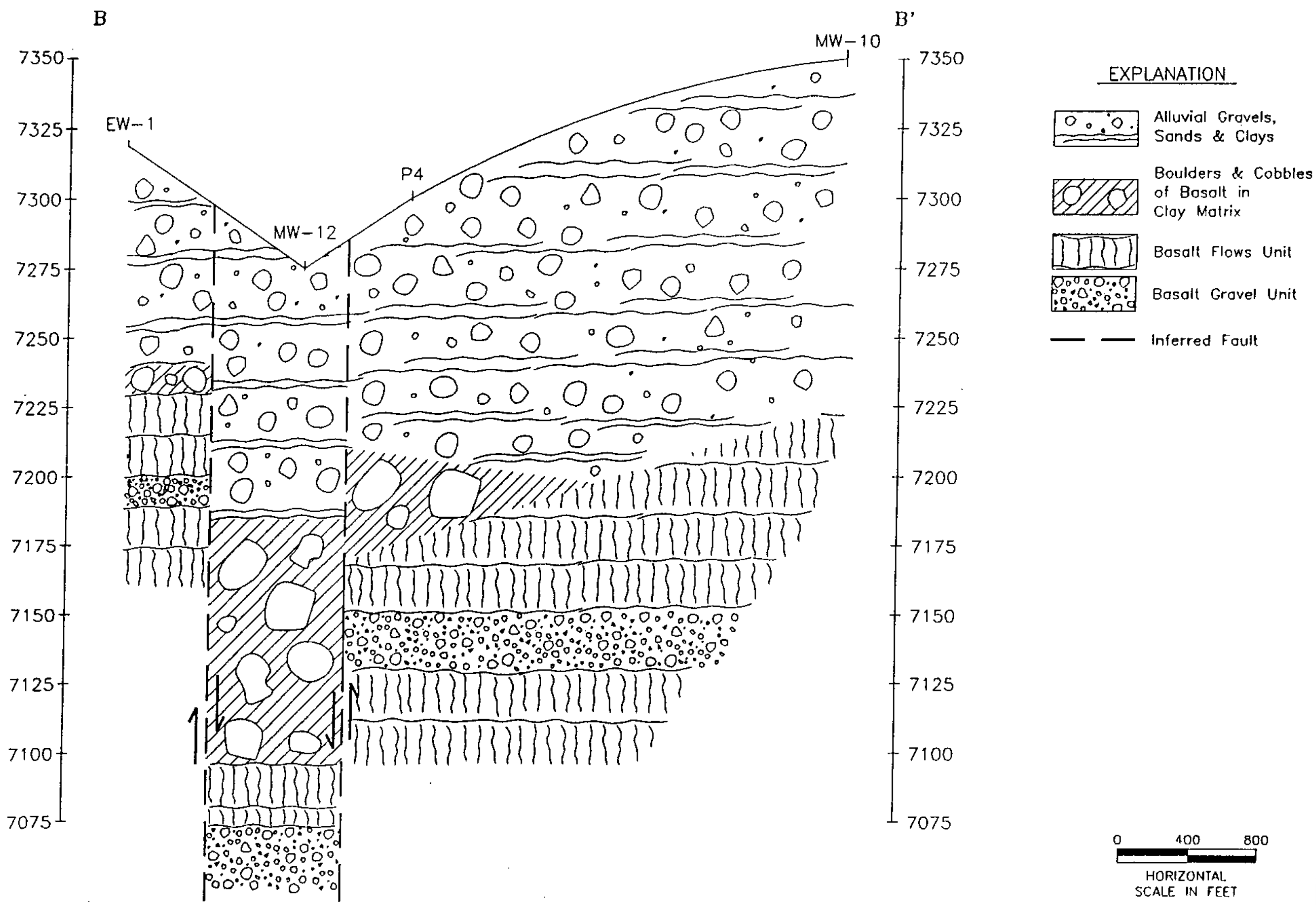

FIGURE: A3	SOUTH PASS RESOURCES, Inc.				GEOLOGIC CROSS-SECTION B-B' SOUTH OF DAM No. 1
	PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.	Tailings Area - Molycorp, Inc. Questa, New Mexico

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APPENDIX B

Detail Of Tailings Area Hydrology And Hydrogeology

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Detail Of Tailings Area Hydrology And Hydrogeology

TABLE OF CONTENTS

Page

B.1 TAILINGS AREA HYDROLOGY 1

B.2 DAM AREA HYDROGEOLOGY 2

B.3 AQUIFER TESTS 6
B.3.1 Aquifer Test: Dam No. 1 Area 6
B.3.2 Aquifer Test: Dam No. 4 Area 8

LIST OF FIGURES

Figure B1: South to North Hydrogeologic Cross-Section
Figure B2: Southwest to Northeast Hydrogeologic Cross-Section
Figure B3: Hydrogeologic Cross-Section West of Dam No. 1
Figure B4: Water Levels for Perched Zones (April 1993)
Figure B5: Water-Level Contours for the UAU Shallow vs. Intermediate Perched Zone
Figure B6: Water-Level Contours for the UAU Perched Zone
Figure B7: Potentiometric Water-Level Relationships
Figure B8: Water-Table Contours of Basalt Aquifer (November 1994)

APPENDIX B

Detail Of Tailings Area Hydrology And Hydrogeology

B.1 TAILINGS AREA HYDROLOGY

Molycorp currently has two earthfill tailings dams constructed across two arroyos: Dam No. 1 in the Section 36 arroyo, and Dam No. 4 in the Section 35 arroyo. The UAU of the Santa Fe Group (approximately 80 to 100 feet thick) underlies both dams. Below the UAU of Dam No. 1 are clays of the MAU. Beneath at least the toe area of Dam No. 4 are volcanic sandstone and conglomerate beds that are very thin (approximately 50 feet thick) and rest on the fractured basalt unit. The pre-dam arroyo beneath Dam No. 4 is broader, and the channel line is approximately 80 feet higher, than the pre-arroyo channel beneath Dam No. 1 (Questa and Guadalupe Mountain 7.5 Minute Quadrangle Maps, 1963). This condition is either the consequence of more erosionally resistant materiel beneath Dam No. 4 (volcanic sandstone and/or basalt) or a reflection of a longer and/or higher volume of discharge through the Dam No. 1 arroyo.

<u>Drainage of Decant Water</u>

The initial drainage of decant water at Dam No. 1 was carried by internal culverts directed to a still pond at the toe of the dam (elevation 7,290 feet) from which it flowed through a ditch southward to the Red River. Subsequently, the decant ponds were clarified upstream of the dam, and decant water was directed through a weir system to the west diversion ditch, to Pope Lake located just south of Dam No. 4, and eventually to the Red River. Since 1983, the decant at Pope Lake was processed at an ion exchange facility next to the lake prior to discharging to the Red River. Diversion ditches were constructed around both sides of the tailings ponds to divert all natural run-off away from the impounded tailings.

The drain system beneath both dams has evolved with time, but basically consists of chimney drains that connect at the base of the dam with blanket and finger drain underdrains (Molycorp engineering drawings). The lowest elevation for the underdrain at Dam No. 1 is about 7,320 feet and at Dam No. 4 is about 7,344 feet. These drains would rest on the UAU beneath Dam No. 1 and probably on the volcanic sandstone unit (based on pre-dam boring logs) at Dam No. 4.

Tailings material was delivered to the pond as a slurry (38 percent solids and 62 percent liquid). Sieve analyses of tailings material (Molycorp files) indicate a range of grain size distributions with median values in the medium to fine sand classes and a <200 mesh fraction (silt and/or clay) that is less than 10 percent to as much as 50 percent of the sample. Slurry water that was not decanted or lost by evaporation infiltrated and was stored in the tailings material. The phreatic surface (top of saturated material) is monitored through a series of piezometers in the dam area and on the tailings surface. A comparison of the 1983 to the 1993 phreatic surface between Dam No. 1 and Dam No. 1C indicates a decline in head of about 19 feet (1.95 feet per year based on 9.75 years, or a rate of decline of 0.005 foot per day).

To monitor the fluid movement through the dams, Geocon (1983), the design engineers for the tailings dams, installed piezometers to measure the phreatic surface. Geocon used finite element code and water-level data from the piezometer in the vicinity of Dam No. 1 to model a flow net consisting of equipotential (equal head) lines and flow lines. On Geocon's flow net cross-section, the phreatic surface slopes south toward the upstream face of Dam No. 1 at a gradient of 0.07 foot/foot (ft/ft). [Note: the 1983 gradient and the SPRI (1993) reported gradient of 0.22 ft/ft are not comparable because the 1983 phreatic surface only extended to the upstream face of Dam No. 1 while the 1993 gradient includes both a piezometer point near the toe of the dam and the steeper gradient at the underdrain.]

The slope of the phreatic surface and the flow lines clearly show discharge to the underdrain system beneath Dam No. 1. The flow-line pattern also shows that flow is toward the bedrock base of the dam and that seepage is moving into the underlying UAU. In their modeling effort, Geocon used an "interpreted" rate of outflow (shown as vertical seepage on their drawing along the base of the tailings area) of 0.003 cubic feet per day per square foot ($ft^3/day/ft^2$) or 0.023 gallons per day per square foot (gpd/ft^2). If the rate of decline in head (based on the change in the elevation of the phreatic surface between 1983 and 1993 is converted from 0.005 ft/day to a vertical seepage, the result is 0.037 gpd/ft^2, in fairly good agreement with the modeling. This is an over simplification of the dewatering of the tailings material because there is a component of horizontal flow toward the underdrain system at Dam No. 1. In other words, the head decline behind Dam No. 1 is a function of seepage through the underdrain system (some of which seeps out along the surface) and seepage through the UAU along the base of the tailings material.

B.2 DAM AREA HYDROGEOLOGY

As presented in Appendix A, the alluvial unit of the Santa Fe Group is a heterogeneous lithologic unit. Logs from borings drilled along the axis of Dam No. 1 prior to its construction (Dames and Moore, 1964) and from monitor wells (SPRI, 1993) indicate that the UAU contains silty clayey gravels with lenses of clay and of relatively clean sand and gravel. The driller's log for the Change House Well (located just east of Dam No. 1) indicates some bouldery material is present in the UAU. Since the source of most of the alluvial material is from the Sangre de Cristo Mountains, the alluvial section would be coarser near the mountains and the clays would pinch out (Winograd, 1959).

The MAU is dominated by clay, but subordinate units of gravel and sand occur. The downward change to the LAU seems to be gradational with increasing amounts of gravel and sand over clay. The log for the Change House well shows some bouldery material at the top of the LAU. The three part division of the alluvial unit (UAU, MAU, and LAU) is modified with the addition of the bouldery clay (i.e. mudflow deposit) beneath the LAU.

Within the Santa Fe Group, lateral hydraulic conductivity is probably significantly higher than the vertical conductivity because of the relative low permeability clay beds. Seepage water (under an hydraulic head driven by mounding within the saturated tailings material) has preferentially migrated laterally along the tops of the clay beds to form shallow perched zones. Monitor wells A, B, and C near the toe of Dam No. 1 and monitor wells MW-7 and MW-9A record shallow water levels related to perched zones. MW-B is periodically dry, indicating the ephemeral nature of some of these perched zones. Seepage Barrier 003 along the east side of Dam No. 4 collects seepage from a perched zone in the UAU. At Seepage Barrier 002, much of the seepage is perched water related to the underdrain system beneath Dam No. 1. Head relationships, at least between the UAU and MAU, indicate a downward flow path. Seepage eventually reaches the water table, which currently is located in the UAU. ?

Prior to the construction of the tailings dam (pre-1965), some information is available on the subsurface units and depth-to-water for the private wells south of the Molycorp property and north of the Red River (well locations are at the ¼ and $^{1}/_{16}$ section level in the northwest and northeast quadrant of Section 1). The wells do not have measuring point elevations so they can not be used to calculate flow directions and gradients. Topographic contour data for well elevations and the approximate location on the Questa 7.5 minute map probably indicate that the shallow wells (less than 100 feet deep) are screened in the UAU/MAU units. The water-level elevations for these wells are very close to elevations along the channel of the Red River.

Geocon (1989), in their response to the New Mexico Environment Improvement Department's comments on the Guadalupe Mountain study, indicated that the original arroyo surface in the area of Dam No. 1 was typically wet with local springs and ponds. Whether this condition was related to perched water or the static water table is unknown. Winograd's (1959) water-level contour map indicates that the water table is close to the surface in this area, but acknowledges that the water levels used are a composite of water table, semi-perched, and artesian conditions. Long-time residents of the area recall cottonwood trees in the arroyo near the present dam and seepage water in one of the tributary arroyos. There are numerous springs in the fields along the north bank. of the Red River. The pre-tailings dam ground-water information indicates that saturated zones (perched?) were fairly close to the surface.

Two of the monitor wells constructed in 1993, MW-8 (replacement well screened in the basalt flow above the basalt gravel) and MW-9B (screened in the lower MAU or upper LAU) gave water-levels within a few feet of the bottom of the well. Subsequent water-level measurements (as recently as November 1994) have shown these two wells to be dry. In 1993, when MW-7 was drilled, several thin perched water zones were logged followed by a narrow interval described as dry clay in the MAU. At this point, the possibility of an unsaturated zone beneath a thick perched water zone involving the lower UAU and upper MAU became a possibility.

In September 1994, the results of a test performed at MW-9B confirmed that the formation opposite the MW-9B screen was unsaturated. Calculation of borehole volume, including an estimated 20 percent porosity for the gravel pack, indicated that 145 gallons of water would saturate the borehole below the seal at MW-9B. To test for the level of saturation, 250 gallons of water was added through the 2-inch piezometer at MW-9B. The 250 gallons was taken by the formation indicating a lack of saturation.

Resistivity logs for EW-2 and MW-12 (constructed in 1994), coupled with subsequent water-level measurements, also support the presence of an unsaturated interval in the MAU. At EW-2, the resistivity logs show two gravel zones (at 112 and 128 feet) in the lower MAU, both of which appeared to be water bearing (see Appendix C). The top of the main gravel zone (LAU) is at 148 feet. The open borehole gave a depth-to-water of 98 feet and that information, combined with the logs, led to the setting of screens for the two upper gravel zones and the main lower zone. When depth-to-water was measured at the time of well development, it had dropped to 150 feet and has stayed at that level. This occurrence suggests that although there was some perched water in the upper gravel, the water table is much deeper and is associated with the main gravel zone below 148 feet. Resistivity logs at MW-12 (Appendix C) show a sharp increase in resistivity in a gravel and clay interval between a depth of 89 to 114 feet, suggesting a thin unsaturated zone. This interval corresponds to part of the screened interval at MW-9B described above.

Figures B1, B2, and B3 are hydrogeological cross-sections illustrating the location of a perched zone involving the UAU and MAU and an underlying unsaturated zone, principally in the lower MAU. The cross-section along the west side of the Dam No. 1 arroyo (Figure B3) shows the unsaturated zone to be in the upper part of the basalt unit (above the basalt gravel). This is based on a limited amount of information taken from the drilling of the two wells at the MW-8 site. The original well was drilled across the basalt gravel which appeared to be saturated (open borehole data). Subsequent collapse of the casing resulted in the drilling of a replacement well which was screened in the basalt above the basalt gravel (to establish head relationships between the two units). However, subsequent to an initial water-level reading in the lower part of the screened interval, MW-8B has been a dry well. (An open borehole depth-to-water of 132 feet below ground surface measured after 12 hours at MW-8A for the lower Santa Fe sediments probably reflects drilling fluid plus some shallow perched zone water and very slow leakage of the borehole fluids out into a clayey formations.) It does not appear that a permanent perched zone equivalent to the main perched zone occurs in the Santa Fe west of the fault zone.

The water levels at MW-1 and EW-1 are near the contact between the basalt and the overlying sediments. At MW-12, the water-level elevation is well above the contact. All three wells are screened in the basalt and the underlying basalt gravel unit. It is possible that the water level at these wells reflects a semi-confined condition for the basalt gravel and that some portion of the basalt above the gravel (as at MW-8B) is unsaturated. The upper 140 feet of the basalt unit at MW-11 is above the regional water table indicating that the regional piezometric surface lies below the contact between the Santa Fe and the basalt.

To summarize, there appears to be sufficient evidence drawn from lithologic and resistivity logs, water-level measurements, and one saturation test to demonstrate a thick perched ground-water zone in the lower UAU/upper MAU south of Dam No. 1. Borehole information from monitor wells west of the fault zone that extends along the west side of Dam No. 1 suggests that the main perched zone does not extend beyond the fault. Only shallow perched zones (e.g., Seepage Barrier 002) are known to occur in the Dam No. 4 area. The eastern extent of the main perched zone is not defined. The east-west extent of the zone is unknown. What happens to the perched zone south of the Molycorp property is also unknown. It may extend to the Red River or it may merge with the saturated LAU. With an upward gradient between the LAU and MAU (as shown by the MW-4 and MW-10 relationship), there would be no chemical impact on the deeper zone. Water-quality data for private wells (P-1 and P-8) and from field springs (Vail, 1993) suggest the perched zone may extend to the river.

Figures B1 and B2 illustrate the existence of several smaller perched zones above the main zone. These smaller zones were recognized when MW-7 was drilled in 1993 and by water-level measurements at piezometers MW-A, -B, and -C. Similar thin perched zones in the upper UAU are being tapped by Seepage Barrier 003 along the east side of Dam No. 4 and Seepage Barrier 002 south of EW-2 and -3. Figure B4 is a cross-section extending from the crest of Dam No. 1 southward to MW-7. It shows the April 1993 water-level surface across the dam and relates this surface to the shallow perched zone in front of the dam. The shallowest zone is probably related directly to the blanket/finger drain system beneath the dam. Water-level contours for these shallow perched zones are illustrated in Figure B5. The configuration of the perched water table for the shallowest zone reflect mounding beneath the dam and a steep gradient to the south (on the order 0.07 ft/ft). Just south of Dam No. 1, depth-to-water increases from the shallowest perched zone to the main perched zone and across this zone to the deeper LAU. The vertical gradient across the alluvial unit is downward.

The water-level contour map for the main perched zone (Figure B6) is based on six water-level measurements. Three of the wells (MW-7A, EW-3, and EW-4) are screened in the basal sand/gravel unit of the UAU, and three of the wells are screened across the lower UAU and upper MAU. Although all of these wells are screened in the upper perched zone, they are not screened in the same interval within the zone and the depth-to-water may vary slightly as a function of screen location. The flow direction and hydraulic gradient are S57°W at 0.016 ft/ft, based on a three-point solution for EW-3, EW-4, and MW-7A. This gradient reflects the steepening of the hydraulic gradient south of Dam No. 1 and is probably related either to the lateral change in hydraulic conductivity or to a westward thinning of the perched zone.

Water-level contour maps were not drawn for the MAU or LAU because a sufficient number of wells have not been screened exclusively in these units. In the case of the LAU, both MW-7C and MW-10 are screened in sands and gravels just below the MAU. The relationship between the saturated LAU in these two wells and the underlying volcanic aquifer is not clearly defined. The third "LAU" well (EW-2) is in fact screened at a deeper level in a gravel unit now recognized as occurring with the bouldery clay unit beneath the LAU. The depth-to-water at EW-2 is significantly deeper and is more closely related to the underlying volcanic aquifer. Figure B7 illustrates this hydrologic relationship. The bouldery clay (mud flow deposit) fills a low area in the top of the basalt aquifer and, in that configuration, functions as a lense of low hydraulic conductivity material bounded laterally by higher conductivity rock. The gravel lense screened at EW-2 is confined within the clay lense, and its potentiometric level approximately corresponds to the potentiometric level associated with the adjacent volcanic aquifer. The relationship between saturated parts of the LAU and BAU and the underlying basalt east of MW-1 and EW-1 is not clear. It is possible that there is a continuous zone of saturation from the lower Santa Fe across the volcanic unit.

B.3 AQUIFER TESTS

B.3.1 Aquifer Test: Dam No. 1 Area

Aquifer tests were conducted in November 1994 in wells EW-2 and EW-3, and attempted in EW-4. The pumping rate at EW-4 was 5 gallons per minute (gpm) (at the lowest range of the pump), but suction was broken at or slightly before one borehole volume of water was discharged, and the testing at this well was terminated. However, successful tests were conducted at EW-2 and EW-3. Pump and Recovery test curves are included in Appendix E.

Well EW-2: This well is screened in a gravel unit enclosed within the bouldery clay deposit below the LAU. In the completed well, the depth-to-water was 151.05 feet. The pump intake was at 177 feet. The test was conducted over an 18-hour period at an average rate of 41.5 gpm. Earlier step tests at 35, 55, and 90 gpm drew water levels below (90 gpm) and close to (55 gpm) the pump intake. The thickness of the saturated interval screened at EW-2 is 30 feet (153 to 183 feet). The aquifer test results gave a transmissivity of 2,608.6 gpd/ft, which corresponds to a conductivity of 86.95 gpd/ft^2. The test was conducted over a period of 10 hours. However, after 15 minutes the drawdown curve flattened out and water levels actually rose slightly during a period of 50 to 90 minutes (Appendix E) indicating that recharge was occurring. The results for transmissivity and conductivity from the aquifer test are probably too low because of the recharge and are much lower than the recovery values. The recovery test for EW-2 lasted for 14 hours. The transmissivity value is 27,390 gpd/ft, which corresponds to a hydraulic conductivity of 913 gpd/ft^2. Recovery was very rapid for the first four minutes, but then settled down to a more gradual rate for the balance of the recovery period (Appendix E). 3x10 3x10

Water-level changes at MW-7C were monitored during the aquifer test at EW-2. At the time of the aquifer tests, several storm fronts passed through the area. Water levels in MW-7C fluctuated over a range of 3.2 inches. Because EW-2 was screened in a confined gravel lense below the LAU and because MW-7C was screened at the top of the LAU, these measured water-level fluctuations were likely the result of barometric changes.

Well EW-3: The aquifer test at EW-3 was the most successful of the three wells tested. EW-3 is screened in a sandy gravel at the base of the UAU (screened from 67 to 77 feet). The pump intake was at 75 feet. A step test at 15 gpm pulled water levels below the pump intake, but 12 gpm kept the water level above the intake and drawdown leveled at 72 feet. However, at these low yields, the pump rate could not be set precisely, and the test was conducted at 7 to 8 gpm (average of 7.5 gpm). The pump test was conducted for 100 minutes and resulted in a calculated transmissivity value of 4,400 gpd/ft which is a conductivity value of 440.0 gpd/ft^2. The recovery test, conducted over a 16-hour period, resulted in a transmissivity value of 2,200 gpd/ft (a conductivity value of 220 gpd/ft^2).

During the aquifer test of EW-3, water-level changes in MW-7A were monitored. Well MW-7A is located 210 feet north of EW-3 and is screened in the same lower sandy gravel of the UAU. Drawdown at MW-7A was 1.21 feet during the aquifer test of EW-3. The recovery curve for MW-7A resulted in a transmissivity value of 2,475 gpd/ft (a conductivity value of 247.5 gpd/ft^2), which is in very close agreement with results at EW-3.

The recovery results at EW-2 and EW-3 are probably more representative of aquifer transmissivity than the aquifer tests. A combination of well storage followed shortly by recharge effects strongly impacted the curves.

The hydraulic conductivity values from the EW-2 and EW-3 tests are compatible with standard textbook values for clean sands and gravels. Estimates of hydraulic conductivity were made from laboratory measurements on samples taken from the MAU during the drilling of MW-9 (SPRI, 1993). These measurements are for saturated vertical hydraulic conductivity (kv), which is lower than the horizontal kv measured from pump tests by a factor of 10 or more. The laboratory values for conductivity range from 0.01056 gpd/ft^2 to 73.3 gpd/ft^2. Using a factor of 10, the upper kv values would be in the range of the aquifer test results.

B.3.2 Aquifer Test: Dam No. 4 Area

Monitor well MW-11 is located just east of the fault zone that runs along the western edge of Dam No. 4 and south of the toe of the dam. The well is screened in the basalt unit (from 207 to 247 feet). Aquifer tests conducted at the well resulted in hydraulic conductivities in the range of 6,833 gpd/ft^2 (specific capacity calculation) to 14,103 gpd/ft^2 (recovery test). Dames and Moore (1986) calculated a hydraulic conductivity of 2,400 ft/day (17,952 gpd/ft^2) from an aquifer test conducted in volcanics at test well GM-5. These values are all well within the published values for permeable basalts (Freeze and Cherry, 1969).

The flow direction ranges from S20°W to S75°W, based on three-point solutions for water-level elevations in the volcanic aquifer [Dames and Moore (1986), SPRI (1993, 1994)] and on a potentiometric map for this aquifer (Winograd, 1959). Differences probably result from combining water levels from different flow paths or localized controls on flowage; nevertheless, a southwesterly flow direction seems to be well established. Three-point solutions for hydraulic gradients range from 0.003 ft/ft to 0.1 ft/ft. Steeper gradients result from localized discharge conditions (such as along a permeable fault zone) or lateral changes in hydraulic conductivity (K) caused by juxtaposing a low K unit down-gradient from a higher K unit. The deep water level at MW-11 may be related to discharge along a fault zone on the west side of Dam No. 4.

The elevation of the Red River at a point 180 feet south of MW-11 lies between the 7,160- and 7,200-foot contours (Guadalupe Mountain 7.5 minute Quadrangle map). The static water level at MW-11 is at 7,152.73 feet, slightly lower than the river. MW-1, also screened in the volcanic unit, has a water-level elevation of 7,228 feet—slightly higher than river level. For the segment of the Red River between Big Springs and Pope Lake, the water table in the volcanic unit appears to be just above river level. In the vicinity of Pope Lake, across the fault zone, there may be some ground-water discharge into the fractured volcanics. The water table gradients probably steepen slightly, bringing the static water level below river level.

Since the river elevation is higher than the water table, there probably is some recharge or loss of flow from the river (but not enough to impact the overall gain recorded by stream gauges). Note that Winograd's (1959) water-level contour map shows a steepening as the gradient across the same area. In the Red River Gorge, the river has steepened its gradient and, at some point, river elevations are below the water table. The point when the water table in the volcanic unit rises above river level probably lies between the Pope Lake area and the Fish Hatchery.

Figure B8 is a water-level contour map for the volcanic aquifer across the front of Dam No. 1 and Dam No. 4. The contour pattern in the vicinity of the Dam No. 1 arroyo shows a ground-water high related to the top of the fault block (on terrace surface) defined by MW-1, EW-1, and MW-8. The structural depression shows a ground-water low (MW-12). The water-level elevation contours mimic the changes in elevation of the top of the basalt. The more southerly flow direction and the steeper gradient (as compared to regional flow) calculated with a three-point solution probably is influenced by the discharge effect at the fault zone near Pope Lake. With the exception of MW-11, there are no subsurface data points for the basalt west of EW-1/ MW-1.

The depth-to-water at MW-11 is 191.93 feet resulting in a water-level elevation of 7,152.73 feet. Well MW-11 is about 200 feet south of the toe of Dam No. 4. It appears that the unsaturated zone below the dam is on the order of 190 feet in thickness (50 feet of Santa Fe Group alluvial material and 140 feet of variable permeable basalt). Drilling history at MW-8A and -8B, combined with the fact that MW-8B (screened in the top of the basalt above the basalt gravel) is dry, indicates that the top of the basalt is unsaturated below Dam No. 4. The water levels at the contact between the basalt and Santa Fe Group at MW-1 and EW-1 probably result from confining conditions for the basalt gravel unit (screened by both wells), and the top of the basalt may be unsaturated here as well. Perched zones above the basalt were not detected in the alluvial sediments above the basalt at MW-11 or EW-1. Seepage from stratigraphic levels above EW-1 is collected at Seepage Barrier 002 along the southeast side of Dam No. 4. ?

Winograd (1959) indicated downward (vertical) gradient between the overlying alluvial material and the basalt aquifer. Water-levels for the basalt aquifer are considerably below the top of the basalt (MW-11), at or slightly above the basalt/alluvial contact (MW-1 and EW-1), or significantly above that contact (50 feet higher at MW-12). The latter may reflect semi-confined conditions associated with the basalt gravel unit within the volcanic aquifer or, more likely, semi-confined conditions created by the boulder clay unit overlying saturated basalt (i.e., saturation may be continuous across the lower Santa Fe and the basalt unit east of the fault zone that extends along the west side of Dam No. 1).

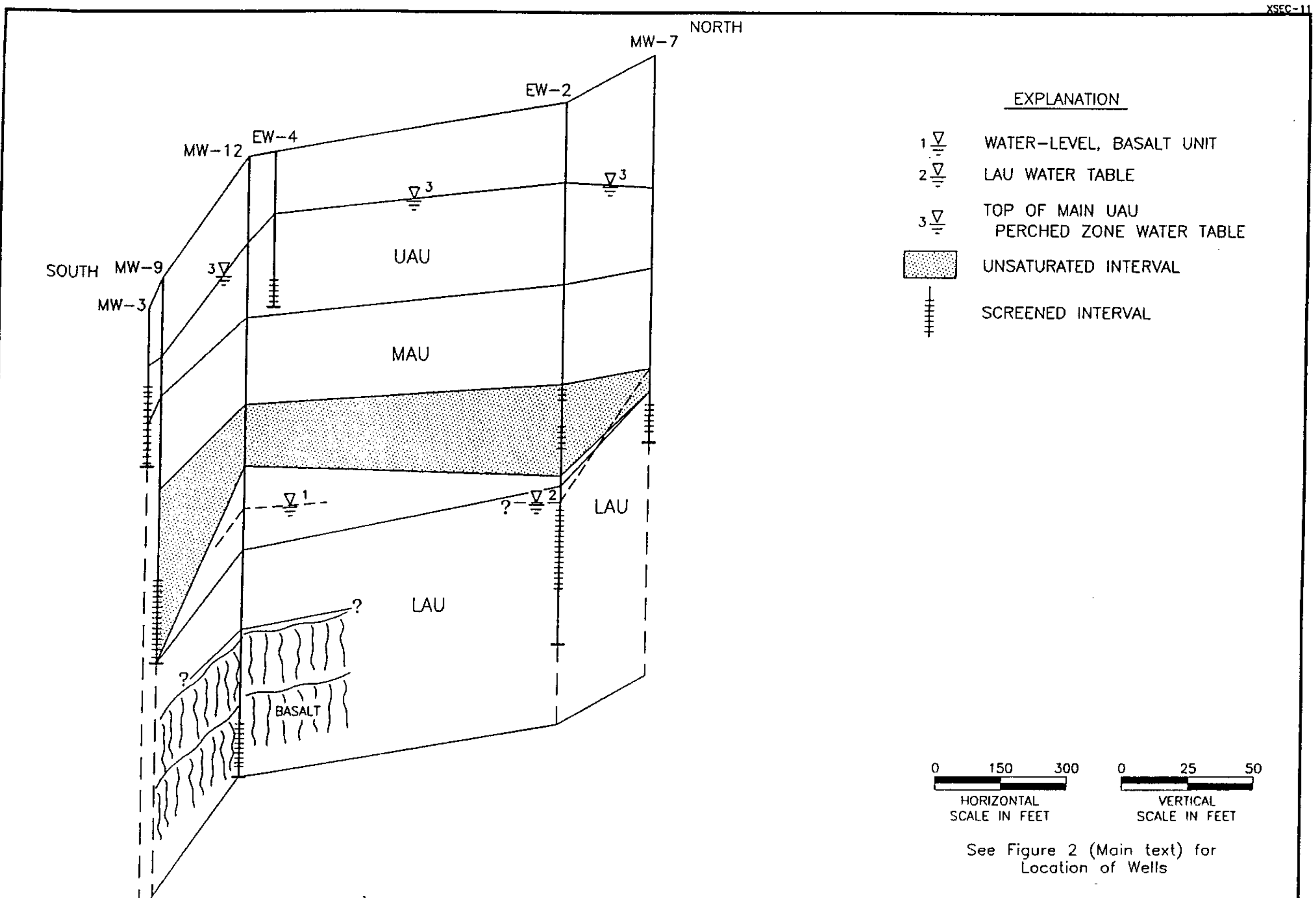
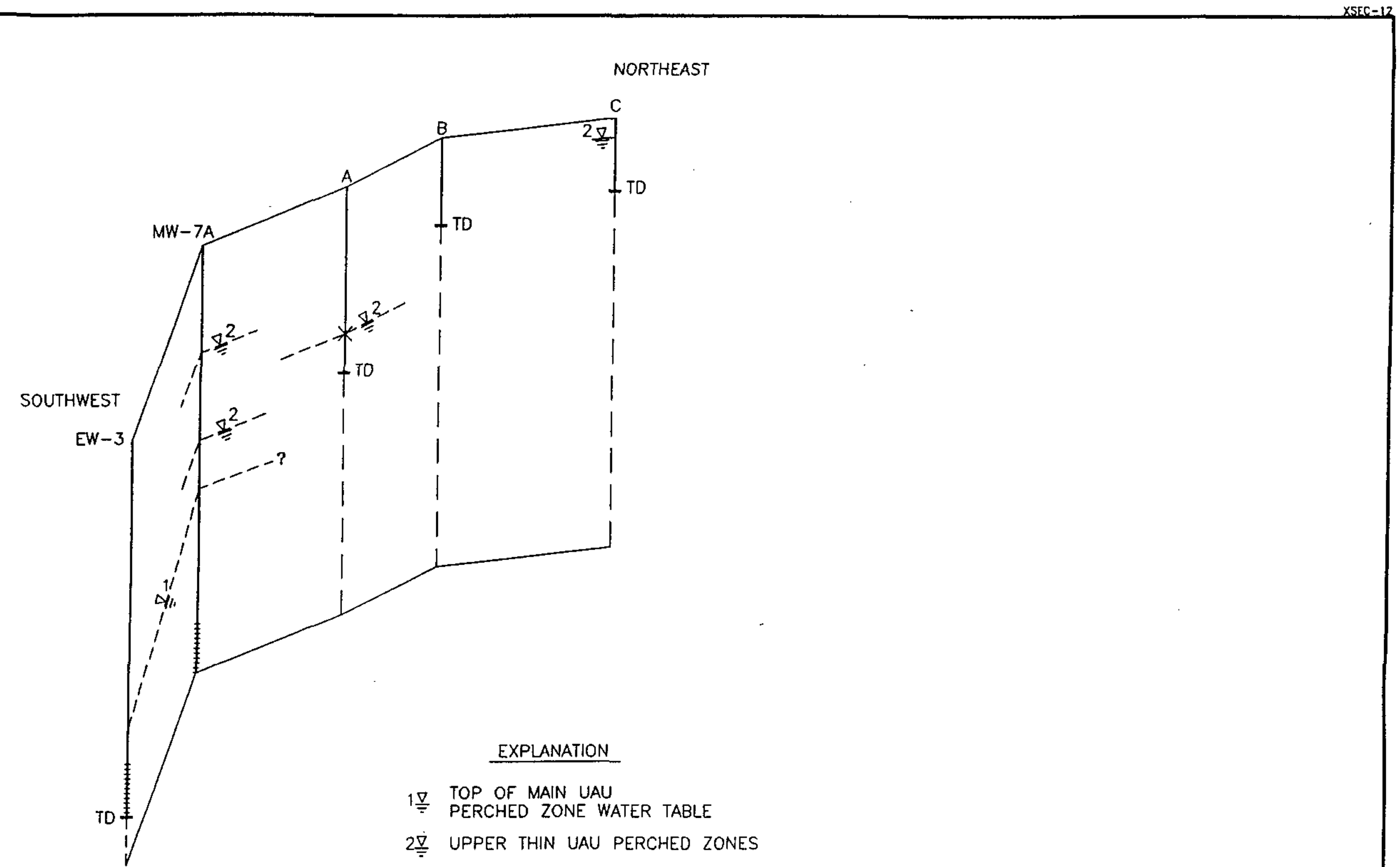


FIGURE: B1	SOUTH PASS RESOURCES, Inc.				SOUTH TO NORTH HYDROGEOLOGIC CROSS-SECTION Tailings Area – Molycorp, Inc. Questa, New Mexico
	PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.	

M-0000503

000453



EXPLANATION

1 TOP OF MAIN UAU PERCHED ZONE WATER TABLE

2 UPPER THIN UAU PERCHED ZONES

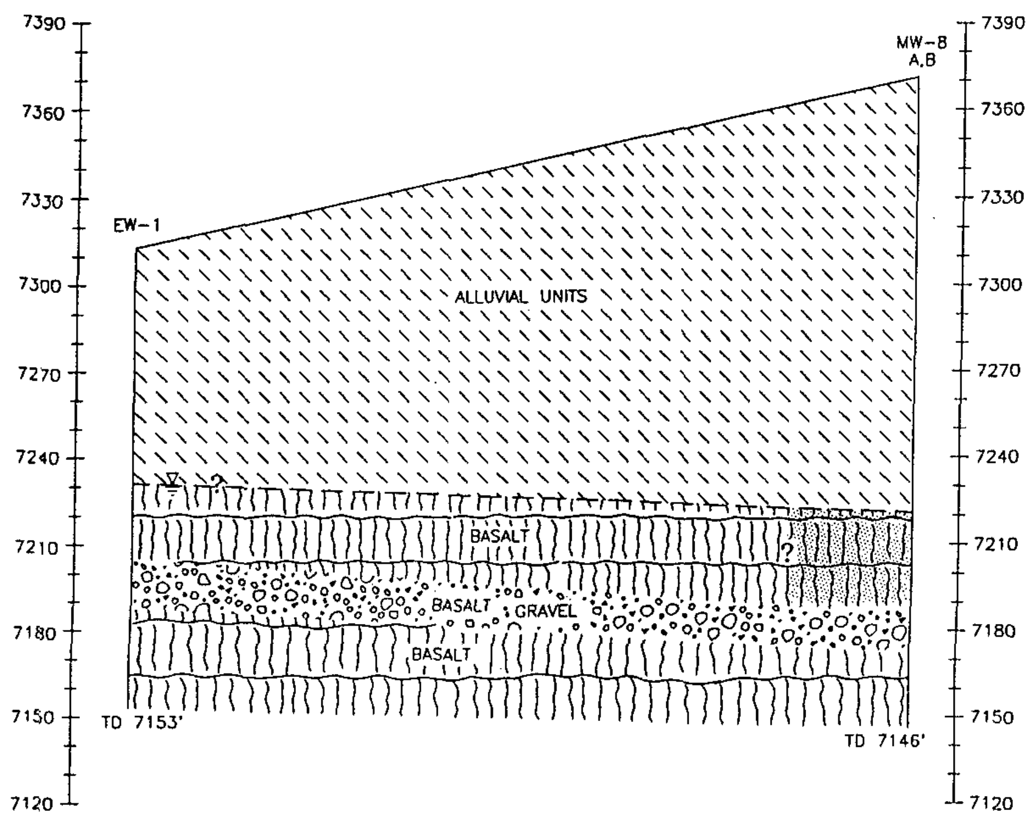
SCREENED INTERVAL

0 25 50
VERTICAL SCALE IN FEET

0 75 150
HORIZONTAL SCALE IN FEET

M-00000504

FIGURE: B2	SOUTH PASS RESOURCES, Inc.				SOUTHWEST TO NORTHEAST HYDROGEOLOGIC CROSS-SECTION Tailings Area – Molycorp, Inc., Questa, New Mexico
	PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.	



EXPLANATION

Alluvial units include the upper and lower aquifers and the Middle Aquitard.

MW-8A,B:
A is the original borehole drilled to 225 feet. B is the replacement borehole drilled to 185 feet.

Potentiometric surface for the volcanic unit where screened intervals include basalt gravel at EW-1 and MW-1.

Unsaturated Zone in the upper part of the volcanic unit above the basalt gravel at MW-8B. May include basalt above gravel at EW-1 and MW-1.

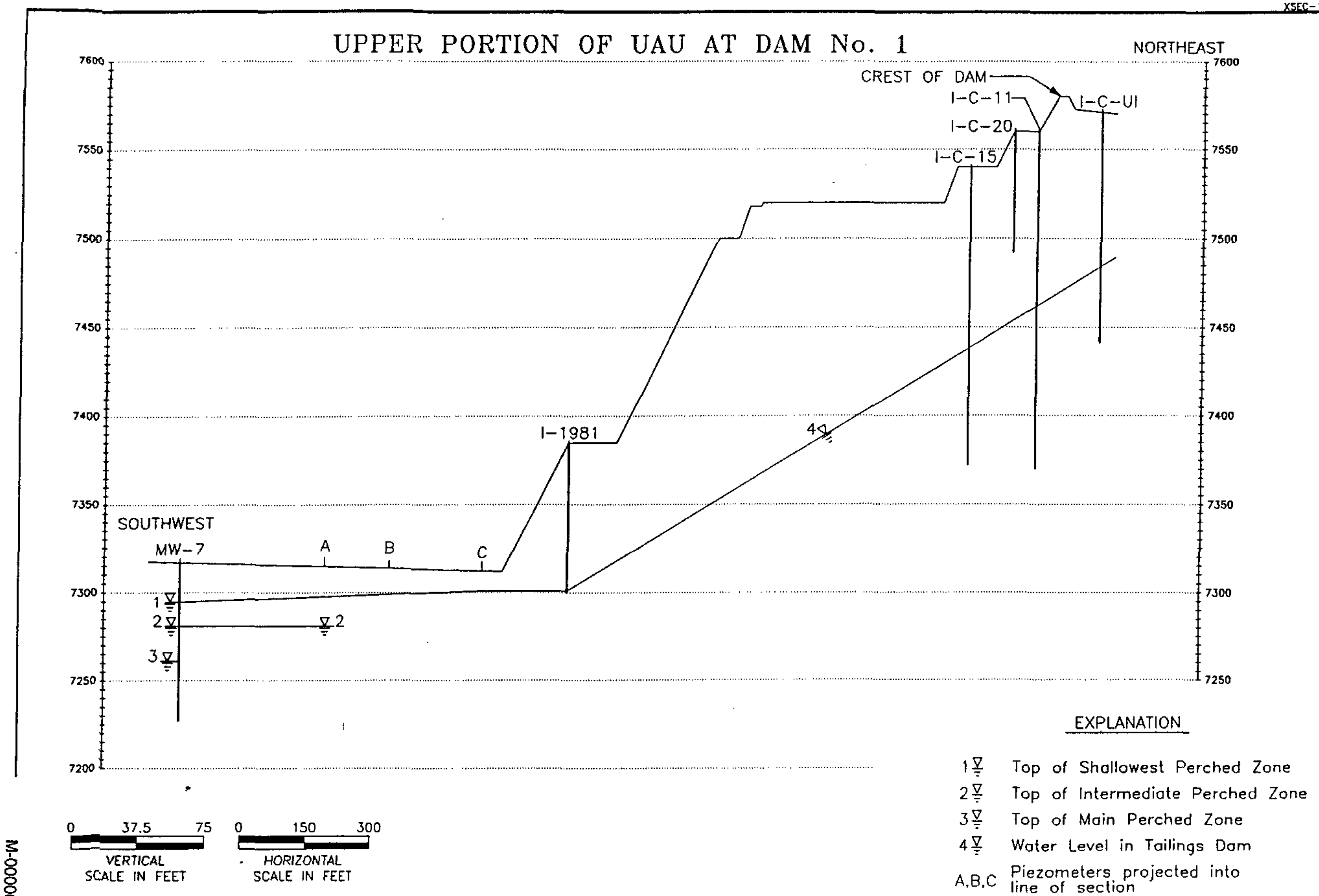
0 30 60
VERTICAL SCALE IN FEET

0 150 300
HORIZONTAL SCALE IN FEET

M-0000505

FIGURE: B3	SOUTH PASS RESOURCES, Inc.				HYDROGEOLOGIC CROSS-SECTION WEST OF DAM No. 1
	PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.	Tailings Area – Molycorp, Inc. Questa, New Mexico

XSEC-15



M-00000506

FIGURE: B4	SOUTH PASS RESOURCES, Inc.			WATER LEVELS FOR PERCHED ZONES (APRIL 1993) Tailings Area – Molycorp, Inc. Questa, New Mexico
	PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.

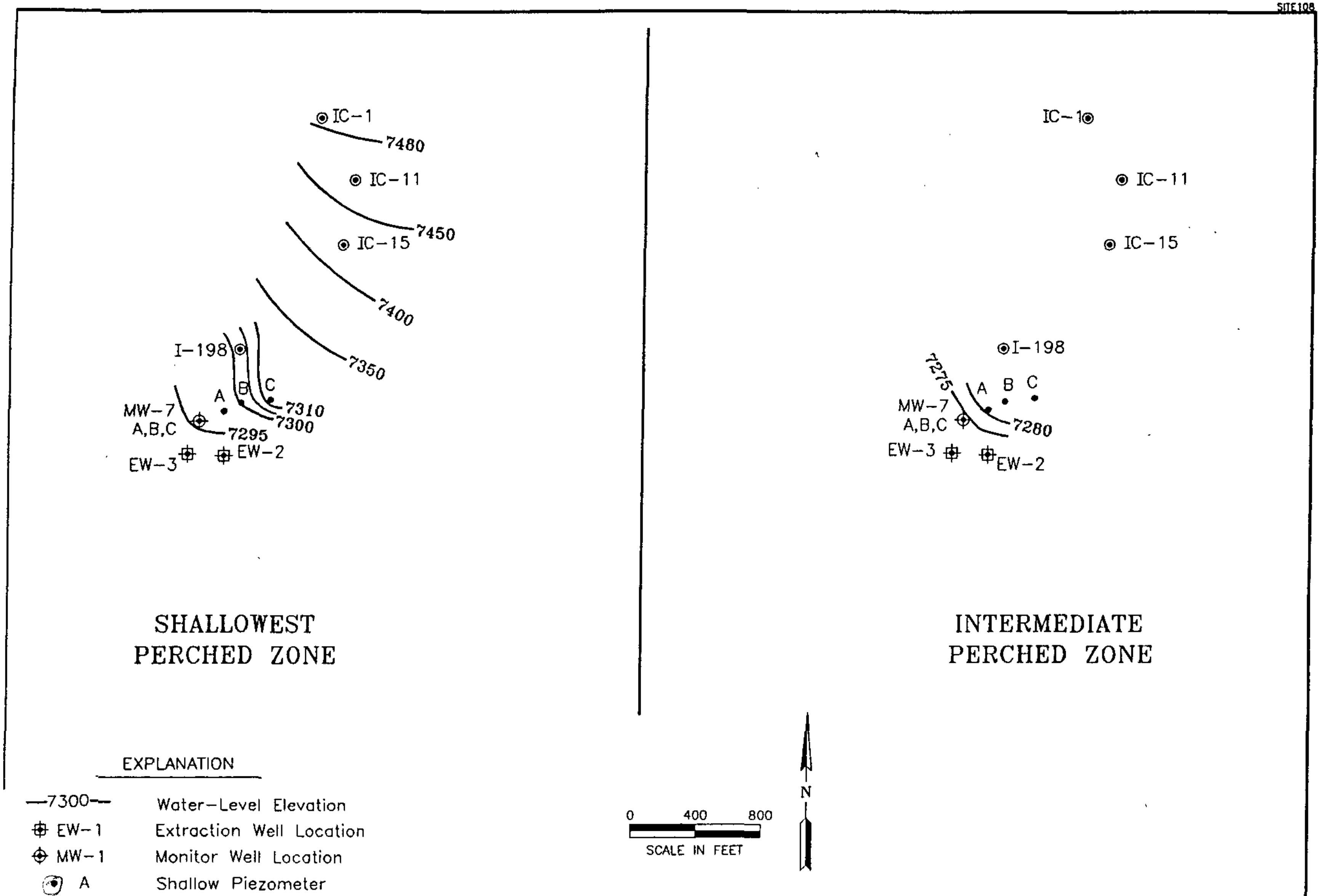
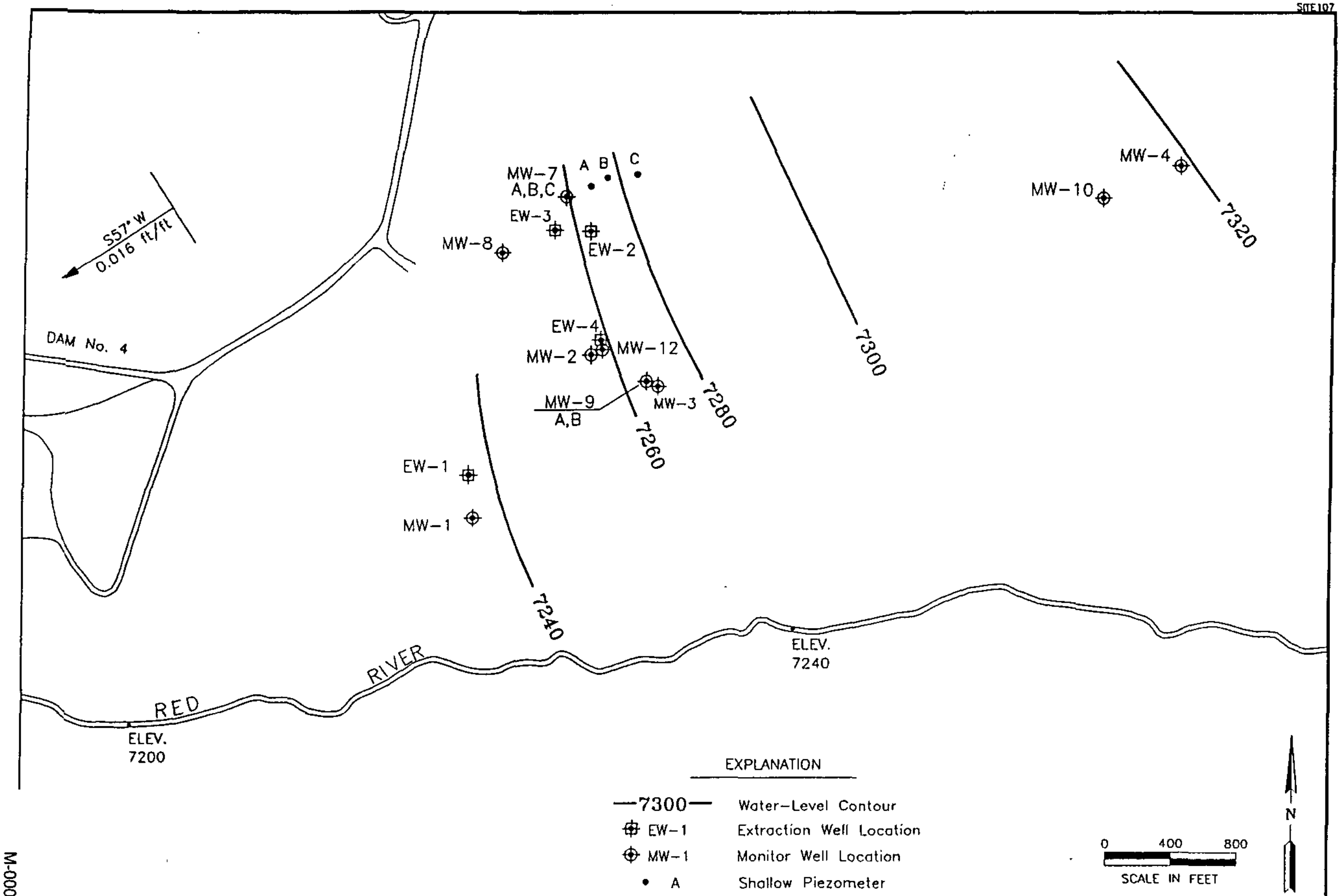


FIGURE: B5	SOUTH PASS RESOURCES, Inc.				WATER-LEVEL CONTOURS OF THE UAU SHALLOW AND INTERMEDIATE PERCHED ZONES Tailings Area - Molycorp, Inc., Questa, New Mexico
	PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.	

M-00000507

000457



M-00000508

FIGURE: B6

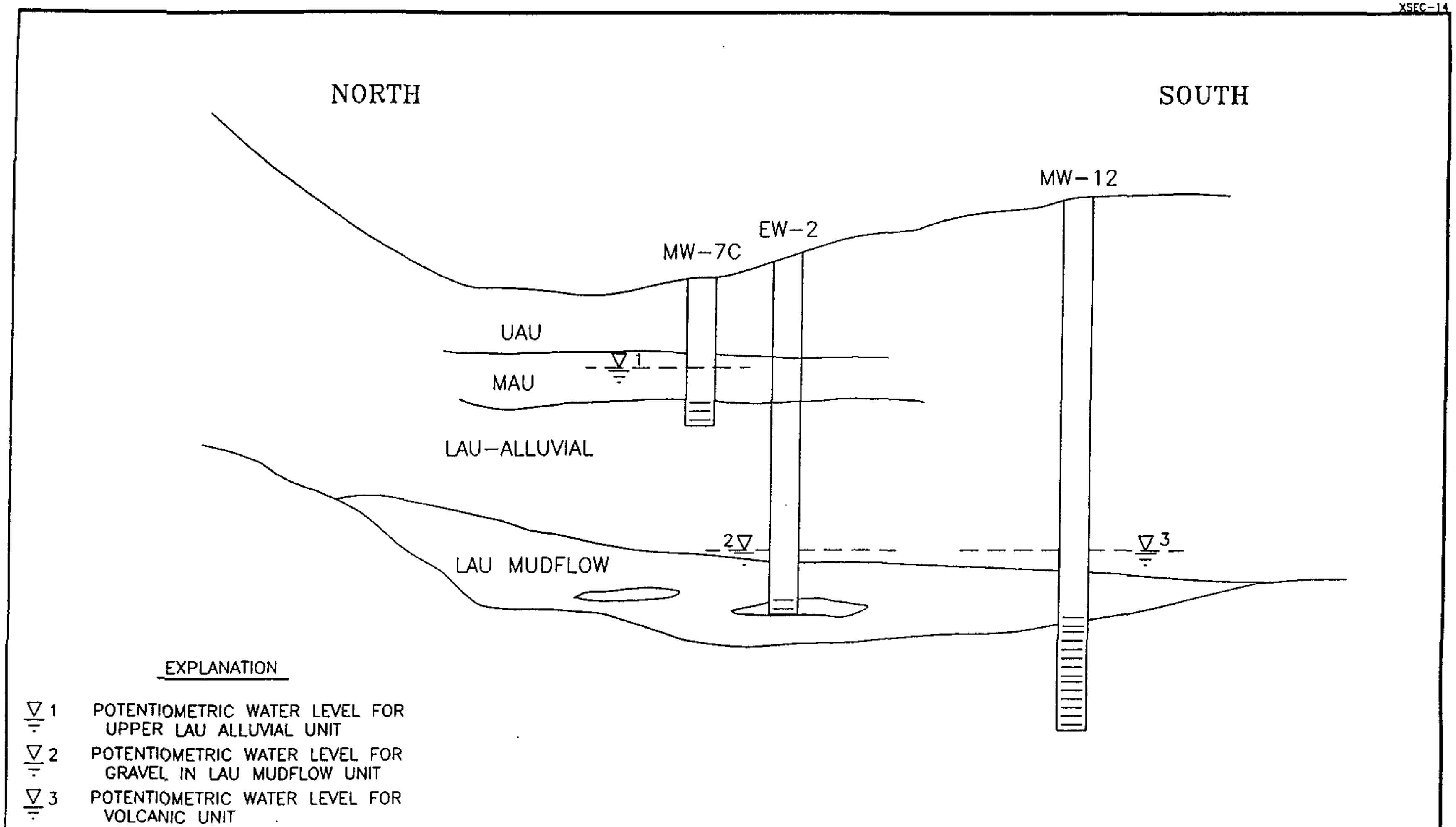
SOUTH PASS RESOURCES, Inc.

PROJECT No.:	DATE:	AUTHOR:	DRAWN BY:
001-06	3/31/95		M.O'M.

WATER-LEVEL CONTOURS OF THE UAU PERCHED ZONE

Tailings Area – Molycorp, Inc.
Questa, New Mexico

000458

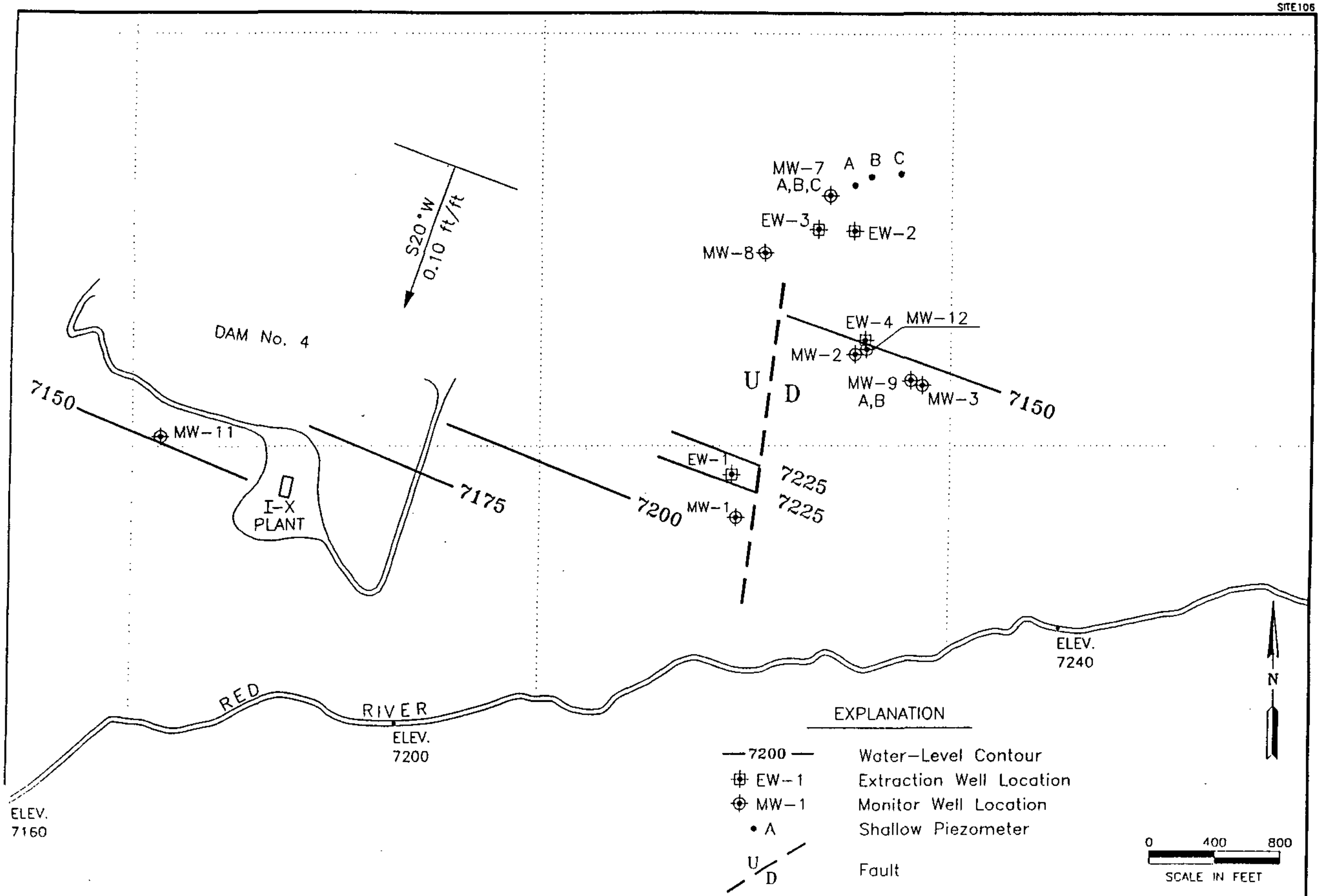


POTENTIOMETRIC WATER-LEVELS FOR THE LAU AND VOLCANIC UNITS

NOT TO SCALE

FIGURE: B7	SOUTH PASS RESOURCES, Inc.				POTENTIOMETRIC WATER-LEVEL RELATIONSHIPS Tailings Area - Molycorp, Inc. Questa, New Mexico
	PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.	

M-00000509



M-00000510

FIGURE: B8

SOUTH PASS RESOURCES, Inc.

PROJECT No.:	DATE:	AUTHOR:	DRAWN BY:
001-06	3/31/95		M.O'M.

WATER-TABLE CONTOURS OF BASALT AQUIFER (11/94)
Tailings Area – Molycorp, Inc.
Questa, New Mexico

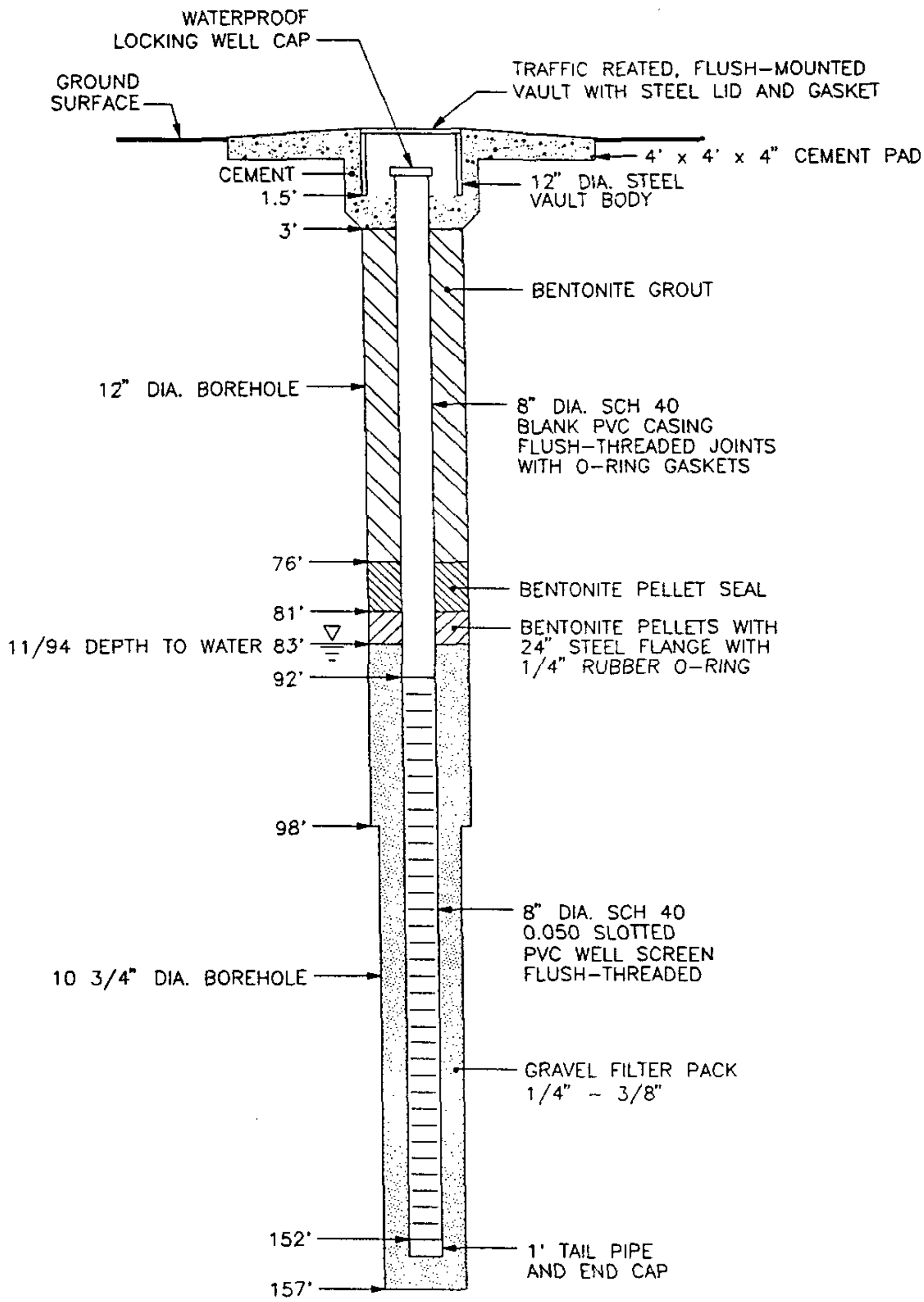
000460

SOUTH PASS RESOURCES, Inc.
SPRI

APPENDIX C

Tailings Area Borehole and Geophysical Logs
(from Fall 1994 Field Investigation)

EW-1

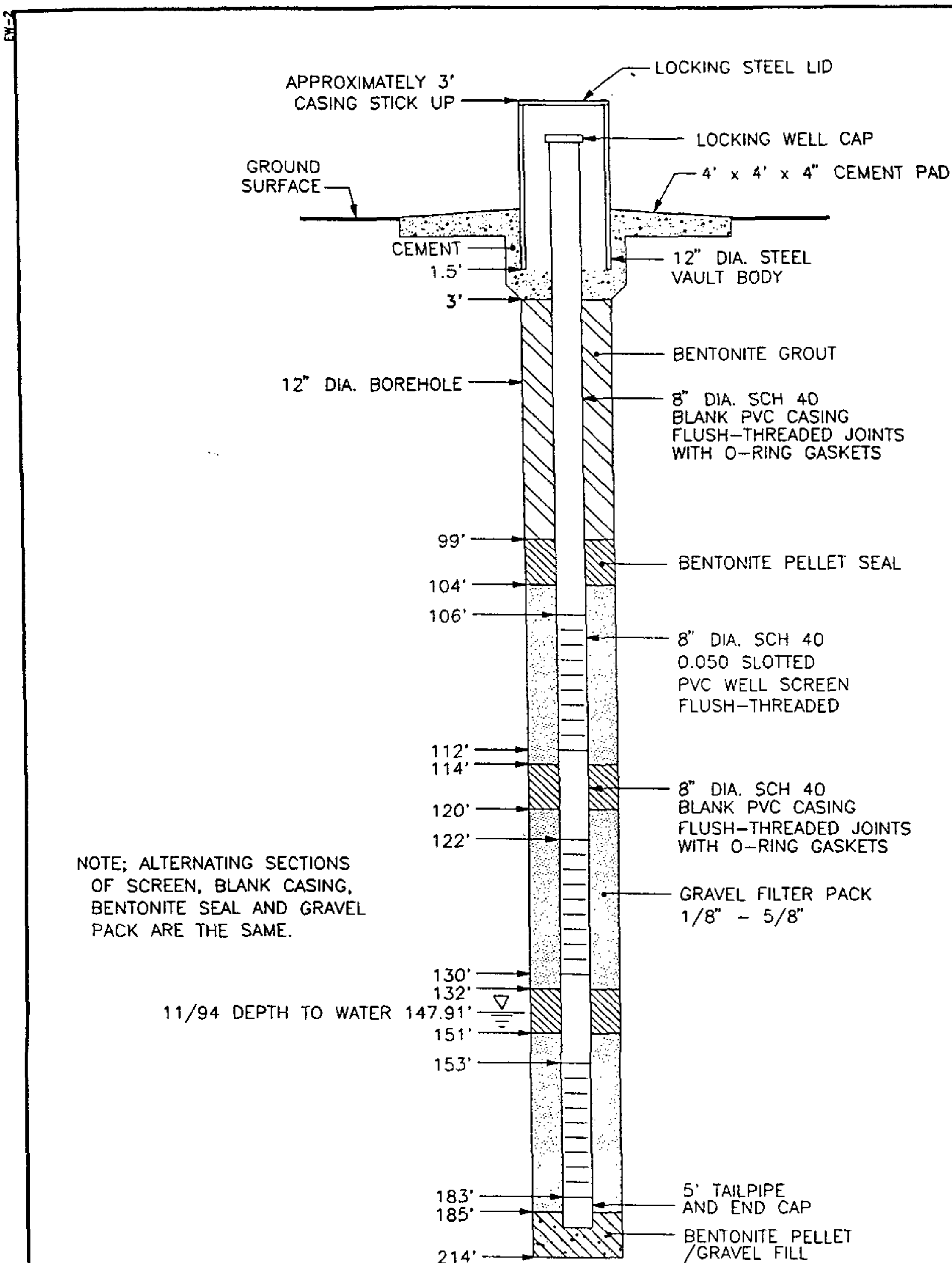


NOT TO SCALE

SCHEMATIC OF WELL CONSTRUCTION

SOUTH PASS RESOURCES, Inc.				MONITOR WELL EW-1 Molycorp, Inc. Questa, New Mexico	FIGURE: C1
PROJECT No.: 001-05	DATE: 2/15/95	AUTHOR:	DRAWN BY: M.O'M.		

M-00000512

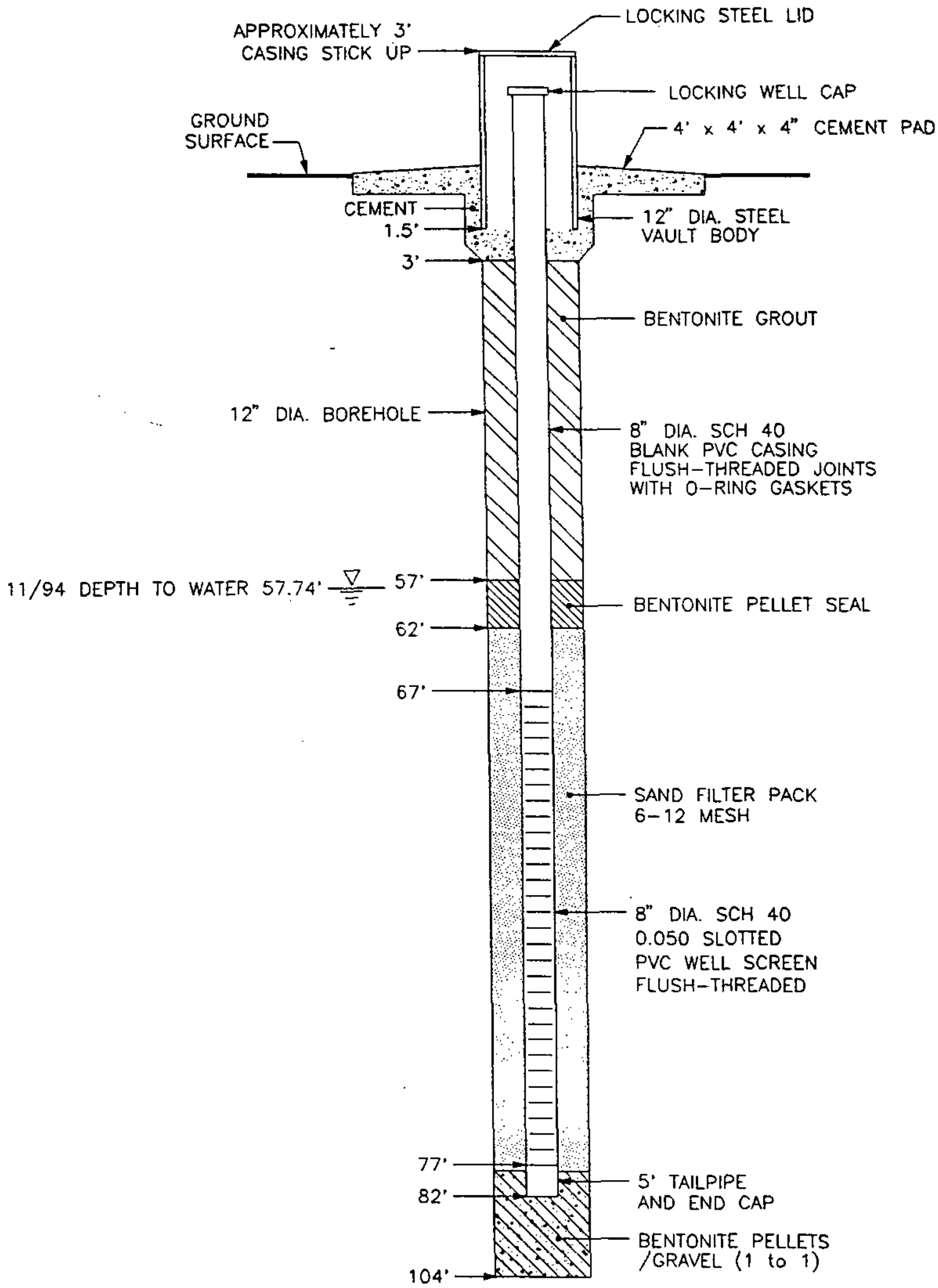


SCHEMATIC OF WELL CONSTRUCTION

NOT TO SCALE

SOUTH PASS RESOURCES, Inc.				MONITOR WELL EW-2 Molycorp, Inc. Questa, New Mexico	FIGURE: C2
PROJECT No.: 001-05	DATE: 2/15/95	AUTHOR:	DRAWN BY: M.O'M.		

M-00000513

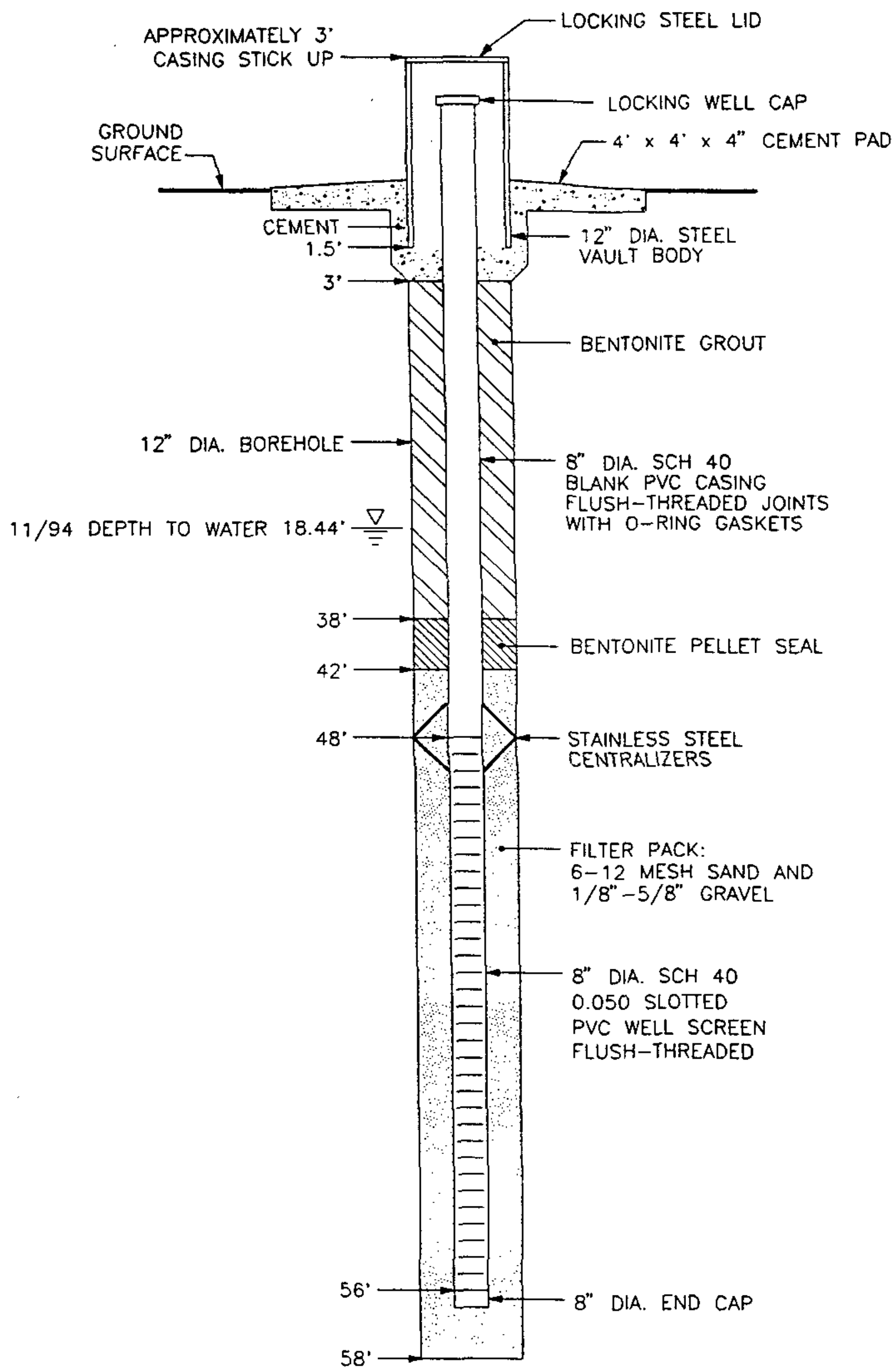


SCHEMATIC OF WELL CONSTRUCTION

NOT TO SCALE

SOUTH PASS RESOURCES, Inc.				MONITOR WELL EW-3 Molycorp, Inc. Questa, New Mexico	FIGURE: C3
PROJECT No.: 001-05	DATE: 2/15/95	AUTHOR:	DRAWN BY: M.O'M.		

M-00000514

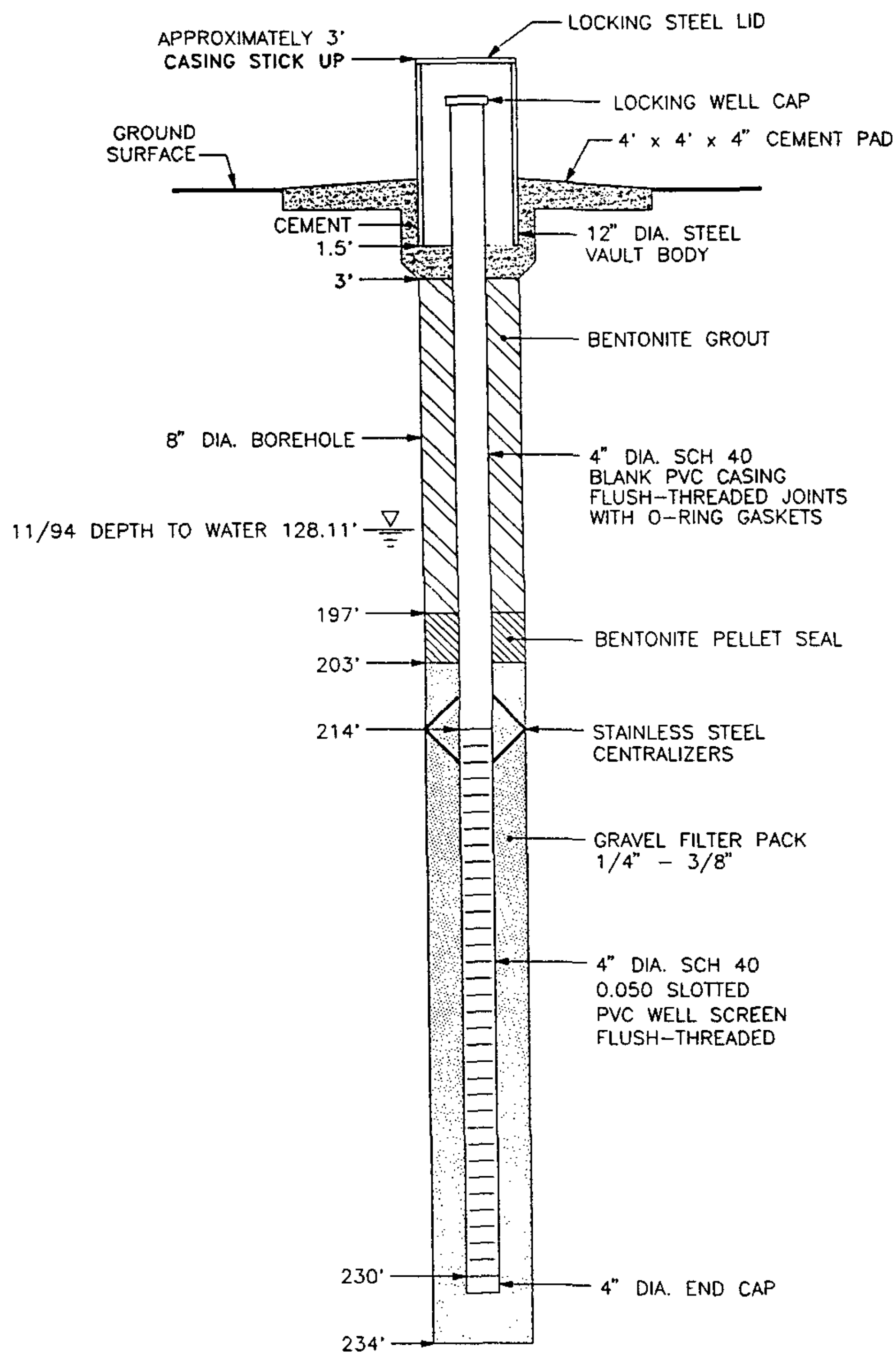


SCHEMATIC OF WELL CONSTRUCTION

NOT TO SCALE

SOUTH PASS RESOURCES, Inc.				MONITOR WELL EW-4 Molycorp, Inc. Questa, New Mexico	FIGURE: C4
PROJECT No: 001-05	DATE: 2/15/95	AUTHOR:	DRAWN BY: M.O'M.		

M-00000515



SCHEMATIC OF WELL CONSTRUCTION

NOT TO SCALE

SOUTH PASS RESOURCES, Inc.				MONITOR WELL MW-12 Molycorp, Inc. Questa, New Mexico	FIGURE: C5
PROJECT No.: 001-05	DATE: 2/15/95	AUTHOR:	DRAWN BY: M.O'M.		

M-00000516

REMARKS	Blows/0.5 Ft.	PID	SAMPLE DEPTH	SAMPLE INTERVAL	GRAPHIC LOG	USCS CLASS	DESCRIPTION
			0			CL	BROWN GRAVELLY SILTY CLAY 10% fine to coarse gravel, clasts of andesite, light-colored volcanic.
			15				silty sandy gravelly clay
			71			SP	SAND fine-grained, calcium carbonate (?) cement.
			73			GC	BROWN CLAYEY GRAVEL clasts of vesicular black basalt.
			80				

DRILL DATE
START: 8/28/94 FINISH: 9/6/94 LOGGED By: W. Opfel DRILL RIG: Air Rotary/ Casing Drive SAMPLE TYPE: Cuttings

SOUTH PASS RESOURCES, Inc.

PROJECT No. 001-05 DATE 1/13/95

LOG OF BORING No. EW-1
Molycorp
Questa, New Mexico

FIGURE No. C6

M-00000517

REMARKS	Blows/0.5 Ft.	PID	SAMPLE DEPTH	SAMPLE INTERVAL	GRAPHIC LOG	USCS CLASS	DESCRIPTION
			80				
			85–110			Rock	BASALT bedrock contact, black vesicular basalt, opal in some vesicules cuttings up to 1 inch.
			110–125			Rock	GRAVEL well rounded to subangular black and red vesicular basalt.
			125–160			Rock	BASALT mixture of basalt gravel and angular basalt chips, angular fragments more common. yellow-brown, red and black vesicular basalt Boring terminated at 160.0 feet and monitor well installed.

DRILL DATE
START: 8/28/94 FINISH: 9/6/94 LOGGED By: W. Opfel DRILL RIG: Air Rotary/ Casing Drive SAMPLE TYPE: Cuttings

SOUTH PASS RESOURCES, Inc.		LOG OF BORING No. EW-1 Molycorp Questa, New Mexico	FIGURE No.
PROJECT No. 001-05	DATE 1/13/95		C6a

M-00000518

REMARKS	Blows/0.5 Ft.	PID	SAMPLE DEPTH	SAMPLE INTERVAL	GRAPHIC LOG	USCS CLASS	DESCRIPTION
			0–10			Fill	GRAVELLY CLAY fill and tailings fines.
			10–29			CL/GC	TAN GRAVELLY CLAY clasts of andesite, rhyolite, basalt and quartz, 60% clay and 40% gravel and coarse-grained sand.
			29–45			CL	TAN CLAY composition of clasts as above, with 10% less coarse-grained sand and gravel.
			45–70			GP/SP	SANDY GRAVEL/GRAVELLY SAND fine- to coarse-grained sand and gravel, rounded, compositions as above.
			70–80			CL	TAN CLAY with 10% to 15% thin beds of sand and gravel, composition as above. Black basalt common clast types.

DRILL DATE
START: 9/7/94 FINISH: 9/20/94 LOGGED By: W. Opfel DRILL RIG: Air Rotary/ Casing Drive SAMPLE TYPE: Cuttings

SOUTH PASS RESOURCES, Inc.

PROJECT No. 001-05 DATE 1/13/95

LOG OF BORING No. EW-2
Molycorp
Questa, New Mexico

FIGURE No. C7

M-00000519

REMARKS	Blows/0.5 Ft.	PID	SAMPLE DEPTH	SAMPLE INTERVAL	GRAPHIC LOG	USCS CLASS	DESCRIPTION
			80, 85, 90, 95, 100, 105				
			110			GP	SANDY GRAVEL
			115			CL	CLAYEY GRAVEL basalt or andesite boulder at 116'.
			120, 125, 130			CL/GC	TAN CLAY alternating layers of clay with vesicular black and red basalt fragments and rounded basalt gravel in a clay matrix.
			135, 140, 145			SP	SAND fine-grained, cemented, basalt clasts.
			150, 155, 160			GP	SANDY CLAYEY GRAVEL alternating layers of tan clay, rounded basalt gravel in a clay/sand matrix. Gravels 40% to 60% of interval.

DRILL DATE
START: 9/7/94 FINISH: 9/20/94 LOGGED By: W. Opfel DRILL RIG: Air Rotary/ Casing Drive SAMPLE TYPE: Cuttings

SOUTH PASS RESOURCES, Inc.		LOG OF BORING No. EW-2 Molycorp Questa, New Mexico	FIGURE No.
PROJECT No. 001-05	DATE 1/13/95		C7a

M-00000520

REMARKS	Blows/0.5 Ft.	PID	SAMPLE DEPTH	SAMPLE INTERVAL	GRAPHIC LOG	USCS CLASS	DESCRIPTION
			160				
			165			SP	GRAVELLY SAND rounded vesicular basalt clasts mixed with angular chips (boulder) in matrix of basalt sand.
			170				
			175				
			180			GW	SANDY GRAVEL rounded basalt, rhyolite and quartz clasts. Clay layer 182'–183'.
			185			GC	TAN CLAYEY GRAVEL basalt clasts in clay matrix.
						CL	TAN CLAY
			190			CL/GC	GRAVELLY CLAY/CLAYEY GRAVEL black and red basalt chips mixed with clay.
			195				
			200				
			205				
			210				
			215				Boring terminated at 214.0 feet and monitor well installed.
			220				
			225				
			230				
			235				
			240				

DRILL DATE
START: 9/7/94 FINISH: 9/20/94 LOGGED By: W. Opfel DRILL RIG: Air Rotary/ Casing Drive SAMPLE TYPE: Cuttings

SOUTH PASS RESOURCES, Inc.		LOG OF BORING No. EW-2 Molycorp Questa, New Mexico	FIGURE No.
PROJECT No. 001-05	DATE 1/13/95		C7b

M-00000521

REMARKS	Blows/0.5 Ft.	PID	SAMPLE DEPTH	SAMPLE INTERVAL	GRAPHIC LOG	USCS CLASS	DESCRIPTION
			0, 5, 10, 15			CL	SANDY GRAVELLY CLAY volcanic clasts. clayey gravel layer 17'-18'
			20, 25, 30, 35, 40, 45			CL	GRAVELLY CLAY clayey gravel layer 21'-22'
			50			SC	TAN CLAYEY SAND fine-grained.
			55, 60, 65			CL	TAN SANDY CLAY sandy clayey gravel layer 56'-57'
			70			CL/GC	TAN GRAVELLY CLAY/CLAYEY GRAVEL
			75, 80			GC	CLAYEY GRAVEL light and dark colored volcanic and quartz clasts.

DRILL DATE
START: 9/21/94 FINISH: 9/22/94 LOGGED By: W. Opfel DRILL RIG: aIR rOTARY/ Casing Drive SAMPLE TYPE: Cuttings

SOUTH PASS RESOURCES, Inc.		LOG OF BORING No. EW-3 Molycorp Questa, New Mexico	FIGURE No.
PROJECT No. 001-05	DATE 1/13/95		C8

M-00000522

REMARKS	Blows/0.5 Ft.	PID	SAMPLE DEPTH	SAMPLE INTERVAL	GRAPHIC LOG	USCS CLASS	DESCRIPTION
			80–95			CL	BROWN SANDY CLAY
			95–104			CL	BROWN CLAY
			105				Boring terminated at 104.0 feet and monitor well installed.
			110–160				

DRILL DATE
START: 9/21/94 FINISH: 9/22/94 LOGGED By: W. Opfel DRILL RIG: aIR rOTARY/ Casing Drive SAMPLE TYPE: Cuttings

SOUTH PASS RESOURCES, Inc.
PROJECT No. 001-05
DATE 1/13/95

LOG OF BORING No. EW-3
Molycorp
Questa, New Mexico

FIGURE No. C8a

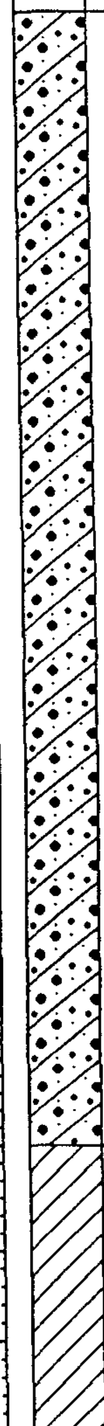
M-00000523

REMARKS	Blows/0.5 Ft.	PID	SAMPLE DEPTH	SAMPLE INTERVAL	GRAPHIC LOG	USCS CLASS	DESCRIPTION
			0–18			GC	BROWN CLAYEY GRAVEL coarse cobbly gravel, light-colored rounded volcanic clasts.
			18–41			CL	BROWN GRAVELLY CLAY clasts composition as above.
			41–58			GC	CLAYEY GRAVEL fine gravel, 20% fines, clasts composition as above.
			58–80				Boring terminated at 58.0 feet and monitor well installed.

DRILL DATE
START: 9/26/94 FINISH: 9/27/94 LOGGED By: W. Opfel DRILL RIG: Air Rotary/ Casing Drive SAMPLE TYPE: Cuttings

SOUTH PASS RESOURCES, Inc.		LOG OF BORING No. EW-4 Molycorp Questa, New Mexico	FIGURE No.
PROJECT No. 001-05	DATE 1/13/95		C9

M-00000524

REMARKS	Blows/0.5 Ft.	PID	SAMPLE DEPTH	SAMPLE INTERVAL	GRAPHIC LOG	USCS CLASS	DESCRIPTION
			0			GC	BROWN CLAYEY GRAVEL fine to coarse cobbly gravel, rounded, welded tuffs, rhyolite, dark volcanic clasts matrix, 20% clay.
			5				
			10				
			15				
			20				
			25				
			30				
			35				
			40				
			45				
			50				
			55				
			60				
			65			CL	BROWN GRAVELLY CLAY gravel as above but in a fine clay (85%).
			70				
			75				
			80				

DRILL DATE
START: 9/23/94 FINISH: 9/26/94 LOGGED By: W. Opfel DRILL RIG: Casing Drive /Air Rotary SAMPLE TYPE: Cuttings

SOUTH PASS RESOURCES, Inc.

PROJECT No. 001-05 DATE 1/13/95

LOG OF BORING No. MW-12
Molycorp
Questa, New Mexico

FIGURE No. C10

M-00000525

REMARKS	Blows/0.5 Ft.	PID	SAMPLE DEPTH	SAMPLE INTERVAL	GRAPHIC LOG	USCS CLASS	DESCRIPTION
			80 – 95				thin layer of basalt gravel, 92'–92.5'
			95			GP	BASALT GRAVEL
			100, 105, 110			GC	CLAYEY GRAVEL/GRAVELLY CLAY light-colored volcanics and black basalt clasts.
			115			CL	BROWN CLAY
			120, 125			GC	CLAYEY GRAVEL black and red basalt clasts.
			130			CL	BROWN CLAY
			135			CL	GRAVELLY CLAY black and brown clasts.
			140, 145			CL	BROWN CLAY
			150, 155, 160			GC/CL	BROWN GRAVELLY CLAY TO CLAYEY GRAVEL brown and black basalt clasts in clay, increasing percentage of basalt clasts with depth; 90% at 154'.

DRILL DATE
START: 9/23/94 FINISH: 9/26/94 LOGGED By: W. Opfel DRILL RIG: Casing Drive /Air Rotary SAMPLE TYPE: Cuttings

SOUTH PASS RESOURCES, Inc.		LOG OF BORING No. MW-12 Molycorp Questa, New Mexico	FIGURE No.
PROJECT No. 001-05	DATE 1/13/95		C10a

M-00000526

REMARKS	Blows/0.5 Ft.	PID	SAMPLE DEPTH	SAMPLE INTERVAL	GRAPHIC LOG	USCS CLASS	DESCRIPTION
			160				
			165				
			170				
			175				
			180			Rock	BLACK BASALT bedrock contact, opal on fractures.
			185				
			190				
			195			GP	GRAVEL fine to coarse rounded clasts of red and black massive and vesicular basalt, quartz clasts present.
			200				
			205				
			210				
			215				tan clay present 210'-220'
			220				
			225				
			230			Rock	BASALT
			235				Boring terminated at 234.0 feet and monitor well installed.
			240				

DRILL DATE
START: 9/23/94 FINISH: 9/26/94 LOGGED By: W. Opfel DRILL RIG: Casing Drive /Air Rotary SAMPLE TYPE: Cuttings

SOUTH PASS RESOURCES, Inc.

PROJECT No. 001-05 DATE 1/13/95

LOG OF BORING No. MW-12
Molycorp
Questa, New Mexico

FIGURE No. C10b

M-00000527

000477

APPENDIX D

Tailings Area Water-Quality Data

APPENDIX D

Tailings Area Water-Quality Data

LIST OF FIGURES

Figure D1: STIFF Diagrams, 1993 Sampling
Figure D2 STIFF Diagrams, 1993 Sampling
Figure D3 STIFF Diagrams - Monitor Wells, 1994 Sampling
Figure D4 STIFF Diagrams - Extraction Wells, 1994 Sampling
Figure D5: Sulfate Concentrations - Upper Perched Zones
Figure D6: Sulfate Concentrations - Main Perched Zone UAU
Figure D7: Sulfate Concentrations - LAU
Figure D8: Sulfate Concentrations - Basalt Aquifer
Figure D9: TDS and Sulfate vs. Time - Perched Aquifer
Figure D10: TDS and Sulfate vs. Time - LAU Aquifer
Figure D11: TDS and Sulfate vs. Time - Basalt Aquifer

LIST OF TABLES

Table D1: 1994 Monitor Well Water Quality Data for Tailings Area

APPENDIX D

Tailings Area Water-Quality Data

This discussion of Tailings Area ground-water quality is based on the analytic results of monitor well water samples collected as split samples with the New Mexico Environmental Improvement Department (NMEID) on August 17 and 18, 1993 and again on November 7, 8, and 9, 1994. Samples were also collected at EW-2, -3, and -4 at the completion of the aquifer tests on November 16 and 17, 1994. The results of the chemical analyses are presented in this appendix. Additional water-quality data from documents in Molycorp files or from other consultants' reports are also presented in this discussion.

A series of STIFF diagrams that provide a comparison of the ground-water chemistry between the monitoring wells sampled in 1993 and 1994 are shown in Figures D1 through D4. STIFF diagrams were replotted from the 1994 data for MW-2, MW-3, and MW-7A and compared to the 1993 diagrams for these wells. Although there have been changes in constituent concentrations, the patterns are similar. Most of the samples reflect the fact that the monitoring system is designed to detect leachate-impacted ground water from the tailings ponds. With some exceptions, the water is classified as a calcium sulfate ground water. In 1993, well MW-7C had a high pH (10.6), high hydroxide (300 mg/L), and high alkali to calcium water (probably as a result of the introduction of cement grout into the annulus prior to the setting of the bentonite seal). By 1994, the pH had lowered to 7.1, the hydroxide had disappeared, and MW-7C had a calcium sulfate water. Water samples from the Change House well in the alluvial material east of the Dam No. 1 pond are alkali (Na+K) bicarbonate and from MW-12 in the basalt aquifer are calcium bicarbonate. These well waters may be closer to the water quality of the regional systems in the alluvial and volcanic aquifers as illustrated in Winograd (1959).

Upper and Main Perched Zones

With the striking exception of EW-4, water samples from the perched zones involving the UAU and the upper MAU are typically high Total Dissolved Solids (TDS) and high sulfate waters (Table D1). Because there is a close correlation between changes in TDS and changes in sulfate concentration, the sulfate values are shown on maps (Figures D5 and D6) to illustrate the sulfate concentration for 1993 and 1994. Figure D6 illustrates changes in the shallow perched zones above the main perched zone in the UAU. The highest sulfate concentrations in this area are at MW-C, the shallowest piezometer at the toe of the dam. This piezometer may be sampling water moving through the underdrains beneath the dam. MW-A shows lower concentrations from an intermediate zone, and both piezometers show a decline in sulfate concentration. In contrast to MW-A and MW-C, the shallow level piezometer MW-9A shows a sharp increase in sulfate between 1993 and 1994. The sulfate concentration at MW-9A is also higher than that in MW-A, even though the latter is closer to the tailings ponds. If leachate moves from the tailings ponds into the UAU in pulses related to annual and/or nonperiodic changes in recharge, the distal increase in sulfate could reflect a slug of older water reaching this site. It is also possible that the ground water is near equilibrium conditions for gypsum and precipitation or dissolution of this species could change the sulfate concentration.

?

The distribution of sulfate in the main perched zone of the UAU is shown in Figure D6. Of the six wells, four were sampled in 1993. Three of these wells (MW-2, MW-3, and MW-4) show declines in sulfate in 1994. In contrast, MW-7A shows an increase in sulfate, although the reason is not clear. It is possible that MW-7A records an earlier slug of leachate from the Dam No. 1 area.

Two wells (MW-2 and MW-3) have higher sulfate concentrations than MW-7A even though the latter is closer to Dam No. 1. Wells EW-3 and EW-4 are located between these wells and have significantly lower sulfate concentrations than the other three wells (MW-2, MW-3, and MW-7A). It is not likely that a single factor will explain these sulfate concentrations, but some combination of the following may be involved:

- Chemical reactions (such as the dissolution or precipitation of interstitial calcite or gypsum along specific flow paths) can cause down-gradient changes in the concentration of the dissolved phases. Monitor wells MW-2 and MW-3, although screened in the main perched zone, are screened across the sands and gravel of the lower UAU and clays of the upper MAU. EW-3 and EW-4 are screened in sandy gravels of the lower UAU only. Ground water entering MW-2 and MW-3 follows a different flow path (in part through clays) than water which is collected by EW-3 and -4. Depending on changes in concentrations over time, the clay is more likely to see fluctuations in dissolution and precipitation of relatively soluble minerals like calcite or gypsum.

- The source of sulfate beneath the tailings pond is not a point source but rather a line source or, in two dimensions, a blanket source (i.e., the area beneath the pond). Sulfate enters the UAU over the area of the pond and is, in turn, more widely distributed by moving laterally along numerous shallow perched zones. Because head relationships in the UAU are downward, ultimately leachate infiltrates to the top of the main perched zone. Once the sulfate (or leachate) reaches the main perched zone, it migrates westward as the water-level map for the zone (Figure D6) shows. With respect to the flow direction in this zone, the down-gradient wells (which are close to the 7,260-foot contour) are MW-7A, MW-2, MW-3 and EW-4. Ignoring EW-4 for the moment, the sulfate concentrations at MW-7A, MW-2, and MW-3 could reflect the location in time and space of an earlier slug of leachate.

- EW-4 is highly anomalous when compared to other UAU wells. As shown on the chart below, the single water sample from this well had a very low TDS (440 mg/L) and sulfate content (150 mg/L). There is a significant decline in the calcium, magnesium, sodium, and sulfate concentrations in the EW-4 water compared to the MW-2 water. A similar decline in calcium and sulfate concentration occurs at EW-3. The reductions in calcium and sulfate concentrations are probably caused by precipitation of gypsum. There was no evidence of gypsum in the drill cuttings and it is likely that precipitation occurred between the time of sampling and the laboratory analysis. Elevated iron and manganese concentrations at MW-2 (relative to EW-4) result from bacterial oxidation of the steel casing at MW-2. The concentrations of zinc and copper at EW-4 increased slightly from the November 7, 1994 sampling to the post-aquifer test sampling on November 16, 1994. This could be an artifact of drilling lubricants introduced when the well was constructed.

	pH	TDS (mg/L)	SO_4 (mg/L)	HCO_3 (mg/L)	Cl (mg/L)	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Na (mg/L)	Fe (mg/L)
MW-2	7.96	1,400	860	80	15	241	52.2	3.1	95.6	4.6
EW-4	7.78	440	150	152	26	101	17.8	1.5	15.5	<0.05

LAU Aquifer

Sulfate concentrations for the LAU and the underlying bouldery clay unit are shown on Figure D7. Although the water-quality data for the LAU at MW-10 and for the deeper private wells south of Molycorp property show little or no evidence of seepage water, the LAU water quality at MW-7C (near the toe of Dam No. 1) has an elevated TDS/sulfate concentration. Head relationships at MW-7 indicate a downward gradient between the LAU and MAU. Some tailings water may be migrating downward into the LAU from the main perched zone and flowing in a southerly direction within the saturated LAU beneath the ponds. MW-10 has high quality water because it is east of the flow path of LAU water from the area beneath the ponds and probably because of an upward gradient preventing tailings water in the UAU/MAU (MW-4) from moving downward.

EW-2 encountered a bouldery clay unit (mud flow deposit described in Section 2.2) beneath the sands and gravels of the LAU. This well is screened in a gravel lense within the bouldery clay and the water sample from this well is of good quality (TDS: 200 mg/L; sulfate: 66 mg/L). The clay matrix of the mud flow deposit effectively seals off these deeper sources from pond leachate.

Basalt Aquifer

South of Dam No. 4, monitor well MW-11, which is screened in the basalt aquifer (Figure D8), shows very low concentrations of TDS (200 mg/L) and sulfate (58 mg/L). This sulfate concentration is lower than that in the Red River north of Questa Springs (141 mg/L) according to unpublished data from Vail (1993). Any leachate that infiltrates form the tailings material behind Dam No. 4 must migrate downward through a thick unsaturated zone consisting of Santa Fe sediments and the upper part of the basalt before reaching ground water. If tailings leachate is moving down into the basalt aquifer, it is rapidly diluted by the southwesterly underflow in the basalt and the monitor well near the toe of the dam produces high quality water (for example, see STIFF diagram, Figure D3).

As a reference in Appendix B, except for seepage along clay beds in the upper UAU (Seepage Barrier 003) southeast of Dam No. 4, there is no clear evidence for saturated conditions in the deeper Santa Fe sediments or in the uppermost basalt flows underlying the Santa Fe Group. Water-level elevations at MW-1 and EW-1 are believed to be related to confined conditions for the basalt gravel unit below the upper basalt flows. The top of the basalt may be unsaturated below Dam No. 4 and west of the fault zone that extends along the west side of Dam No. 1. The fault appears to juxtapose the main perched zone on the east with the basalt on the west. It is more likely that the TDS and sulfate concentrations in MW-1 and EW-1 are related to leachate in the main perched zone which has migrated westward (in the direction of flow) across the fault zone.

Seeps

There is some evidence that the "fault" east of MW-1 may exert some control on the movement of ground water toward the Red River. The projection of this "fault" to the river would approximately correspond to the Questa Springs area and the springs may be directly related to the structure. Water from the Questa Springs area is piped to the Fish Hatchery (approximately 4.5 miles downstream from the springs). This water has a TDS of 173 mg/L and a sulfate concentration of 80 mg/L (Table 3, main text). These concentrations are comparable with LAU or volcanic aquifer water. The temperature of this water (8.3°C) is perhaps more compatible with shallow (LAU) ground water than the temperature (16°C) of the deeper flow system in the volcanics (Vail, 1993).

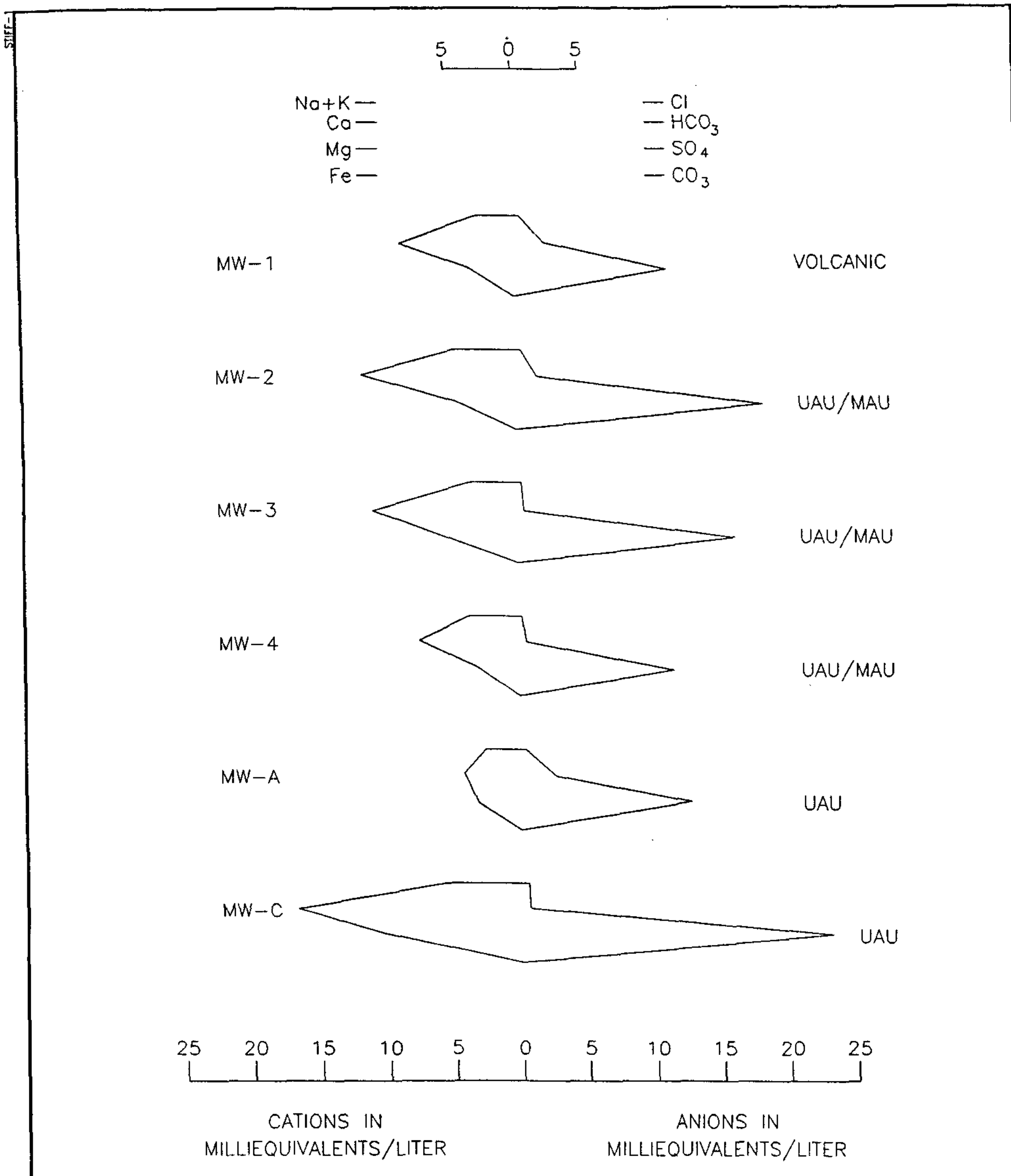
Time/Concentration Plots

A number of variables impact the time/concentration plots for TDS and sulfate shown on Figures D9, D10, and D11:

- Sample collection or analytical errors are a possible cause of variation.
- The sampling periods do not represent the same time of year: 1991 and 1992 are spring samples, 1993 is August, and 1994 is a November set of samples. Concentration changes could be partly a function of variation in seasonal recharge.
- The older wells (MW-1, MW-2, MW-3, MW-4, MW-A, MW-B, and MW-C) have steel casing while the newer wells are all PVC construction. Purging of MW-4 on September 15, 1994 (1,100 gallons) released a significant amount of rust-colored debris (ferrihydrite). MW-1, MW-2, and MW-3 show measurable iron concentrations that may be the result of the release of iron related to bacterial activity. The purging at MW-4 may have temporarily flushed out the iron since its November water sample shows iron being below the detection limit. Once ferrihydrite ("limonite") forms in the casing, this material can selectively absorb trace metals (such as copper and zinc depending primarily on changes in pH. Adsorption is favored at higher pHs). The water quality of steel-cased wells can be influenced by chemical reaction between the casing and the ground water.

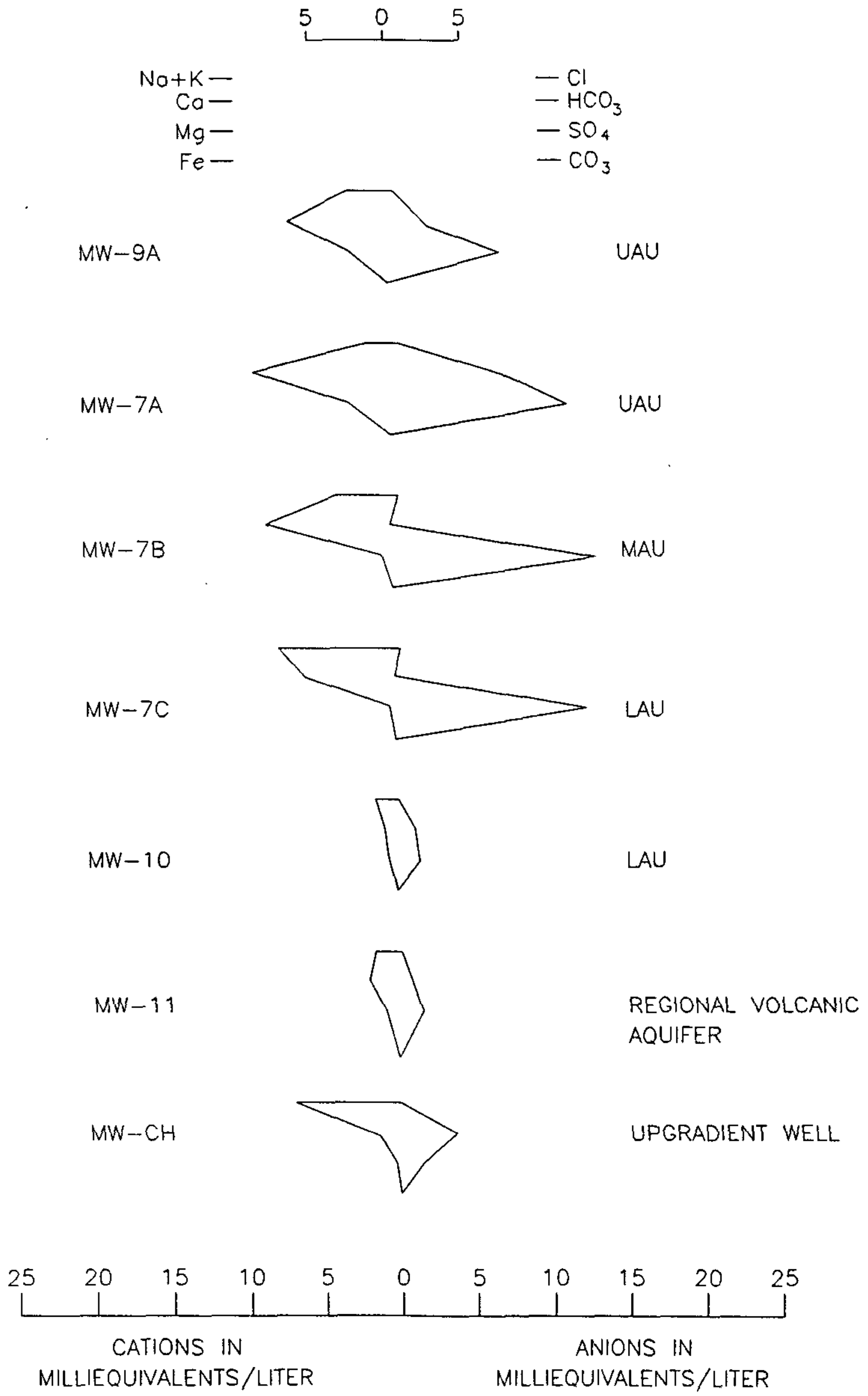
Figure D9 indicates that, in the case of the older wells in the perched aquifers, the concentrations of TDS and sulfates increased between 1992 and 1993. Concentrations decreased after 1993 for all of these wells except MW-3 which show a slight increase. Wells MW-2, MW-3, and MW-4 are all screened over a larger interval (lower UAU and upper MAU) in the main perched zone compared to MW-7A which is screened in the lower UAU. Well MW-7A shows a sharp increase in concentrations from 1993 to 1994. How much of this difference is related to non-hydrogeological factors (described above) is unknown. Hydrogeological causes would involve some combination of variations in (1) recharge superimposed on flow paths, (2) the position of the well along particular flow paths, and (3) chemical processes along the flow path. Similar explanations are involved in the MW-A and MW-C versus MW-9A patterns.

There is very little time/concentration data for the LAU or the volcanic (basalt) aquifer (Figures D10 and D11). Samples from well MW-1 show a decrease in concentration from 1992 to 1993 and a slight increase in 1994. This may reflect a time lag related to recharge of the volcanic aquifer from the main perched zone to the east. Samples from well MW-11 show a decrease in concentrations from 1993 to 1994, possibly resulting from declining heads in the pond material and reduction of the amount of leachate reaching the water table. The two LAU samples (MW-7C and MW-10) show opposite trends. Samples from MW-7C parallels concentration changes in samples from MW-7A. The MW-10 sample may simply reflect annual variation as a function of regional variation in recharge.



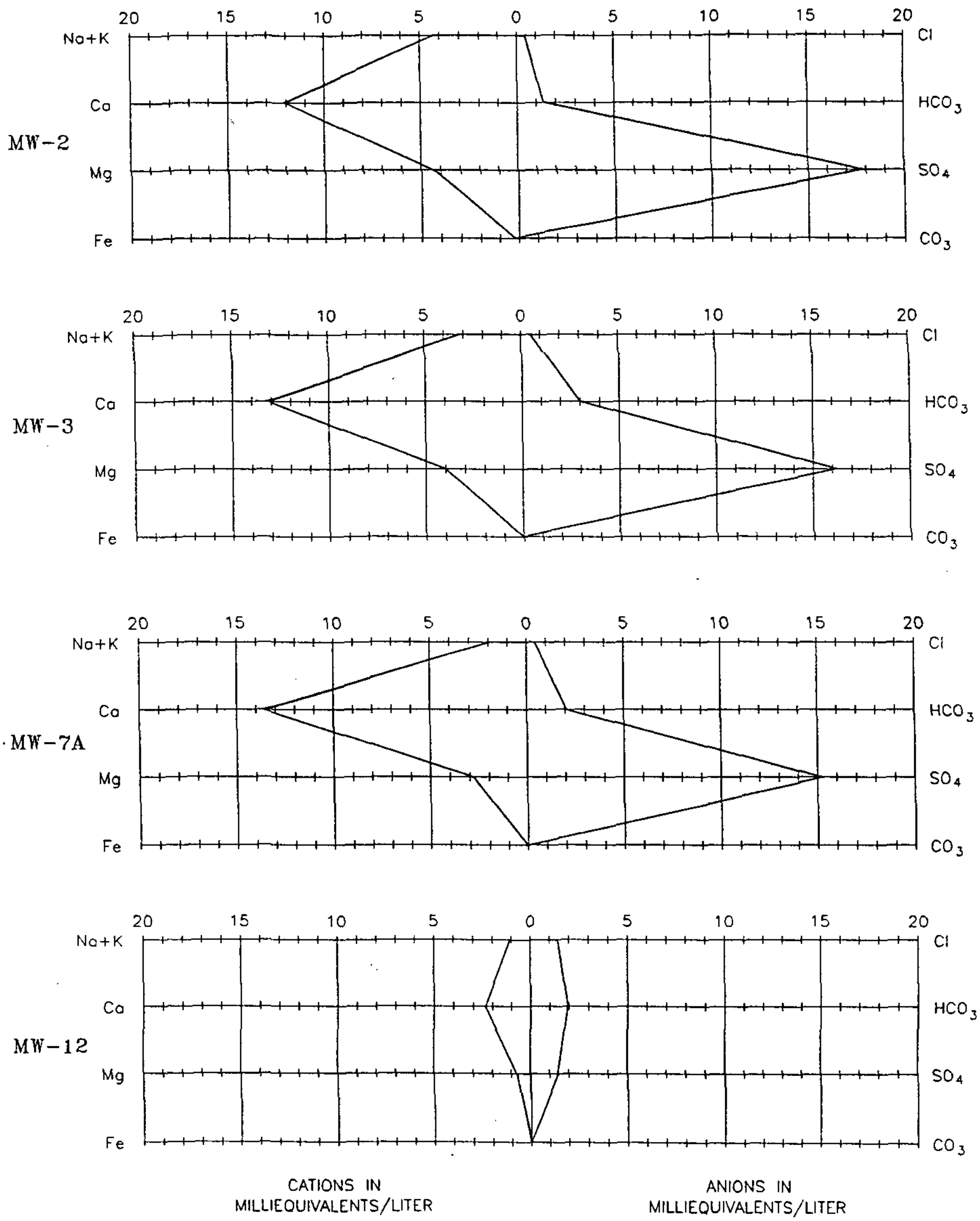
SOUTH PASS RESOURCES, Inc.				STIFF DIAGRAMS-1993 SAMPLING Tailings Area - Molycorp, Inc. Questa, New Mexico	FIGURE: D1
PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.		

M-00000536

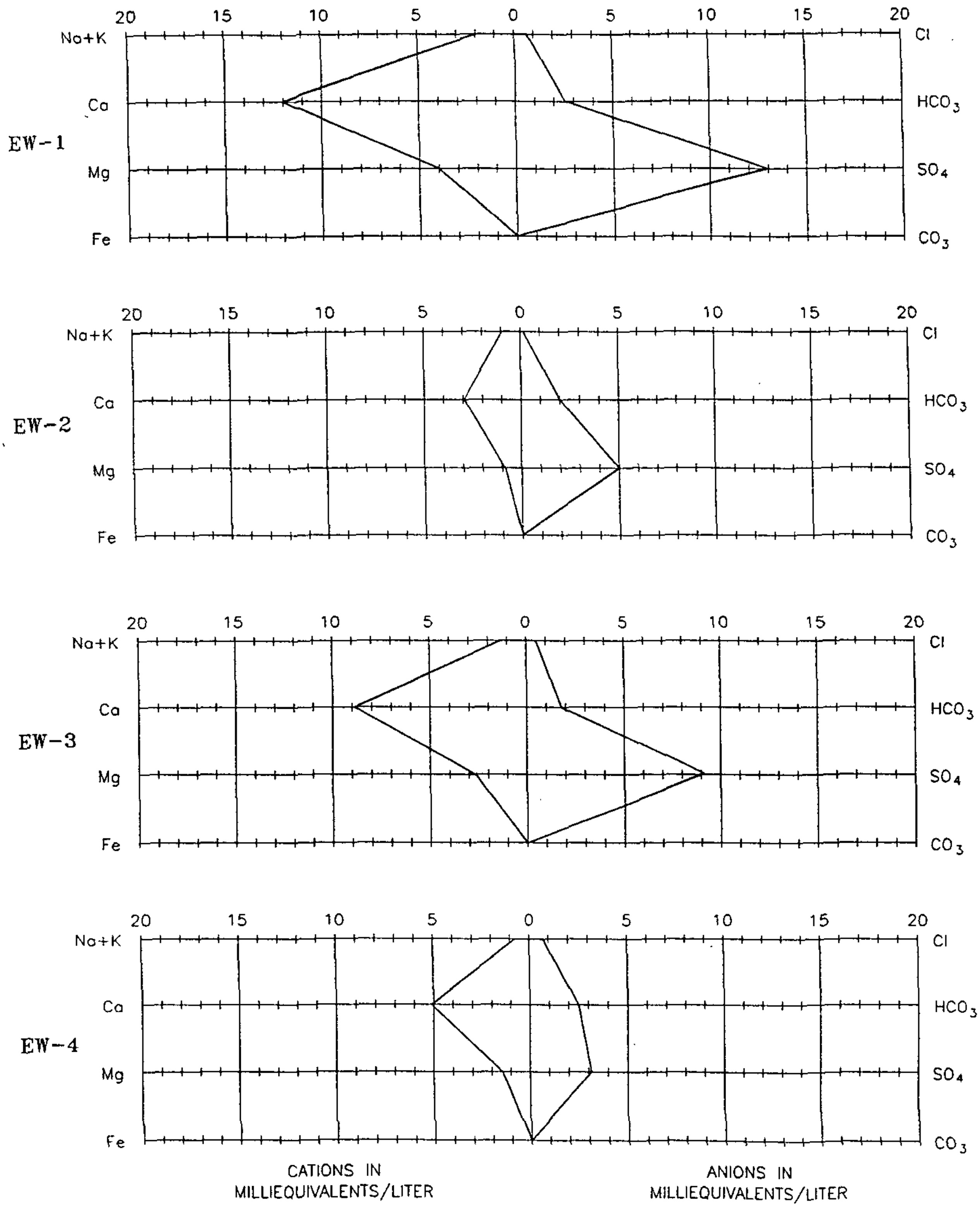


SOUTH PASS RESOURCES, Inc.				STIFF DIAGRAMS-1993 SAMPLING Tailings Area - Molycorp, Inc. Questa, New Mexico	FIGURE: D2
PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.		

M-00000537

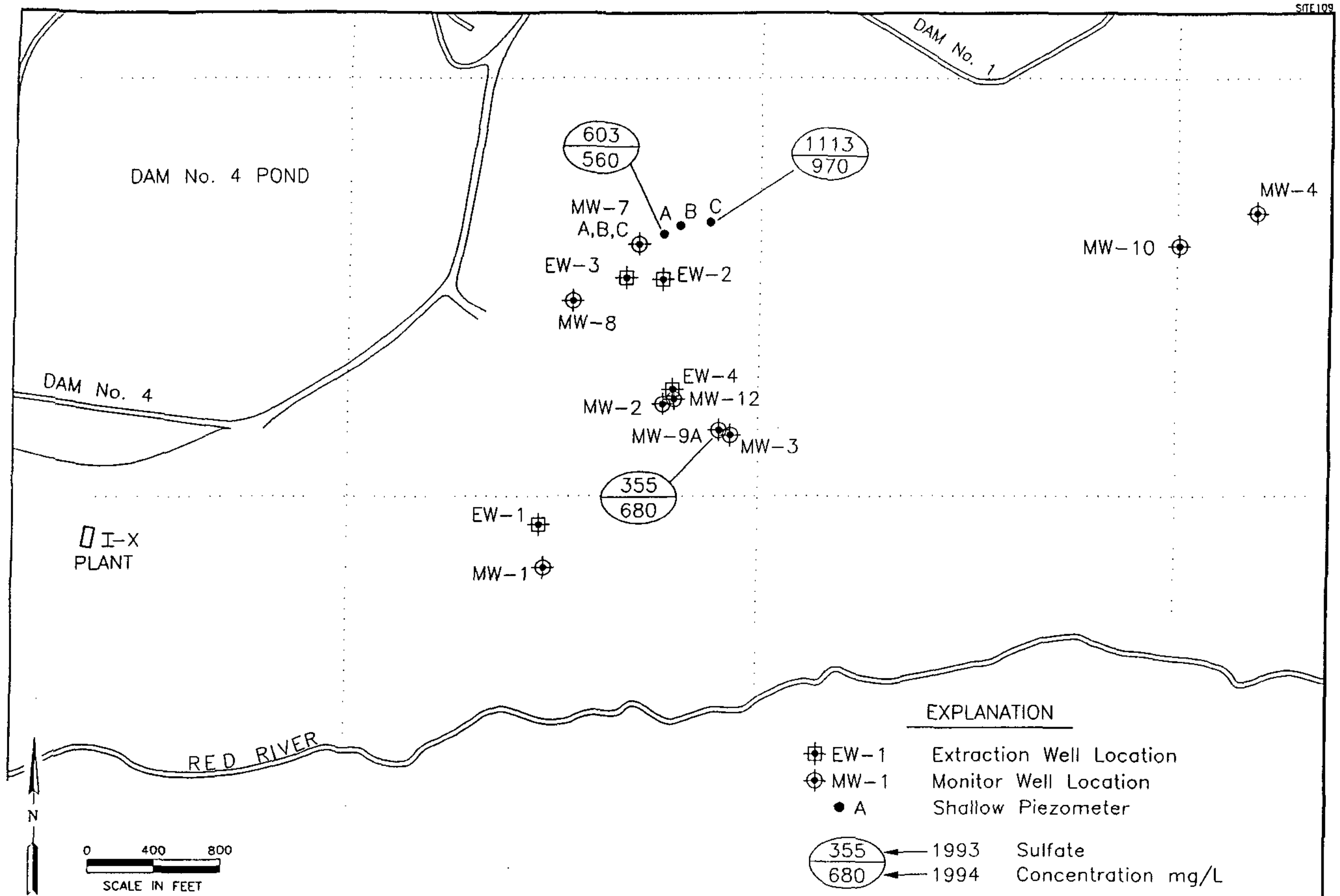


SOUTH PASS RESOURCES, Inc.				STIFF DIAGRAMS-1994 SAMPLING Tailings Area - Molycorp, Inc. Questa, New Mexico	FIGURE: D3
PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.		



SOUTH PASS RESOURCES, Inc.				STIFF DIAGRAMS-1994 SAMPLING Tailings Area - Molycorp, Inc. Questa, New Mexico	FIGURE: D4
PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.		

M-00000539



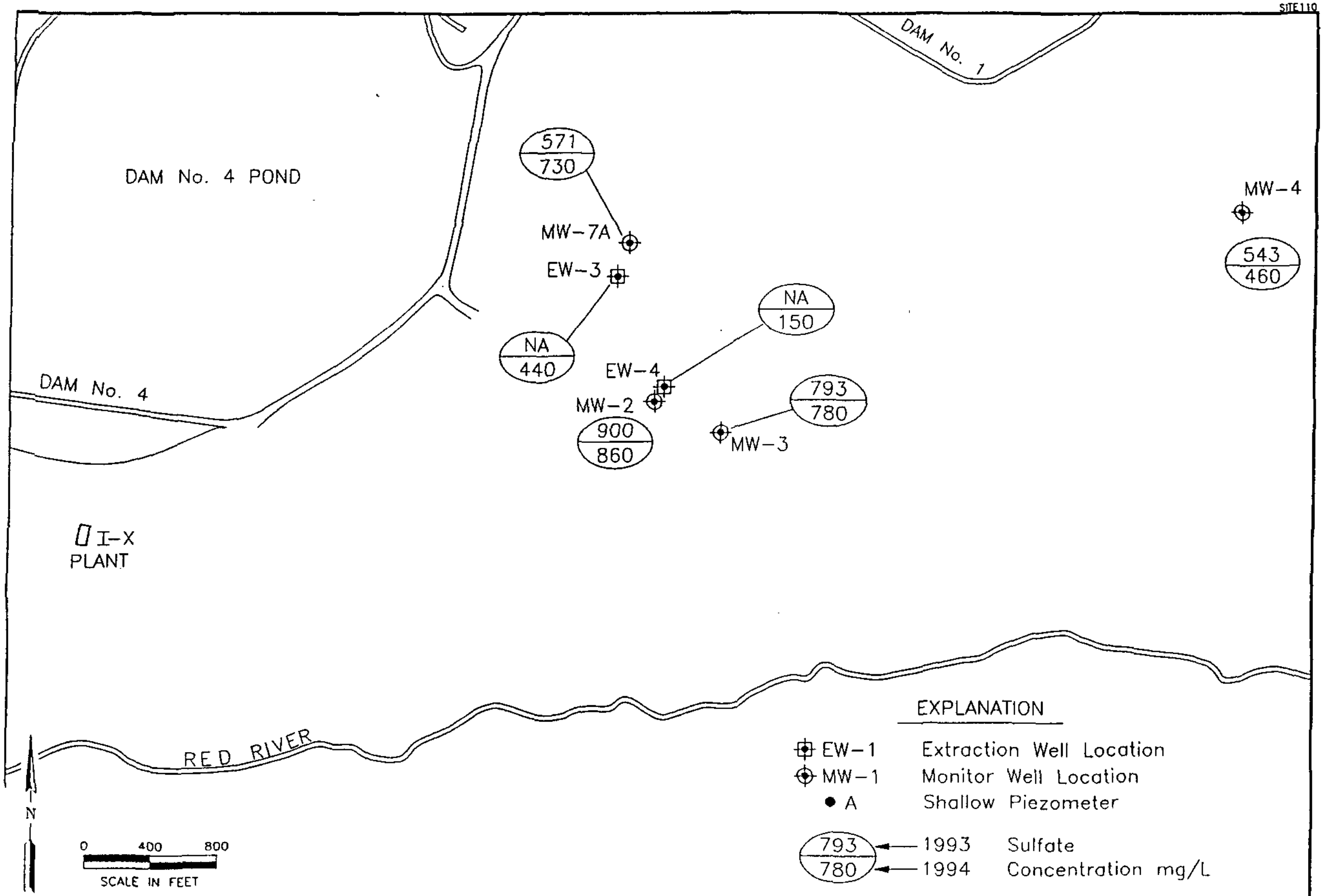
M-00000540

FIGURE: D5

SOUTH PASS RESOURCES, Inc.

PROJECT No.:	DATE:	AUTHOR:	DRAWN BY:
001-06	3/31/95		M.O'M.

SULFATE CONCENTRATIONS-UPPER PERCHED ZONES
ABOVE MAIN PERCHED ZONE IN UAU
Tailings Area, Molycorp, Inc., Questa, New Mexico



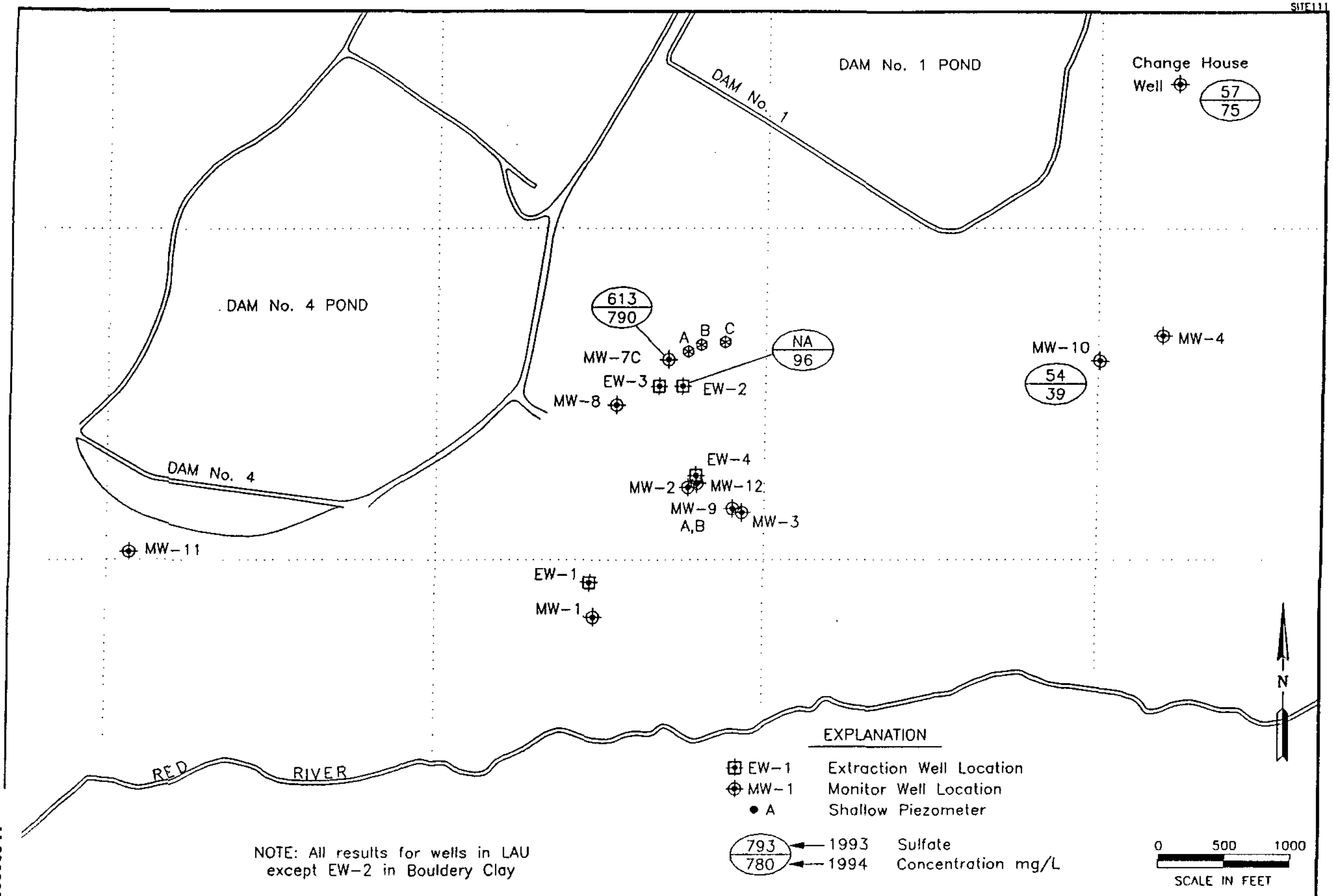
M-0000541

FIGURE: D6

SOUTH PASS RESOURCES, Inc.

PROJECT No.:	DATE:	AUTHOR:	DRAWN BY:
001-06	3/31/95		M.O'M.

SULFATE CONCENTRATIONS MAIN PERCHED ZONE UAU
Tailings Area – Molycorp, Inc.
Questa, New Mexico

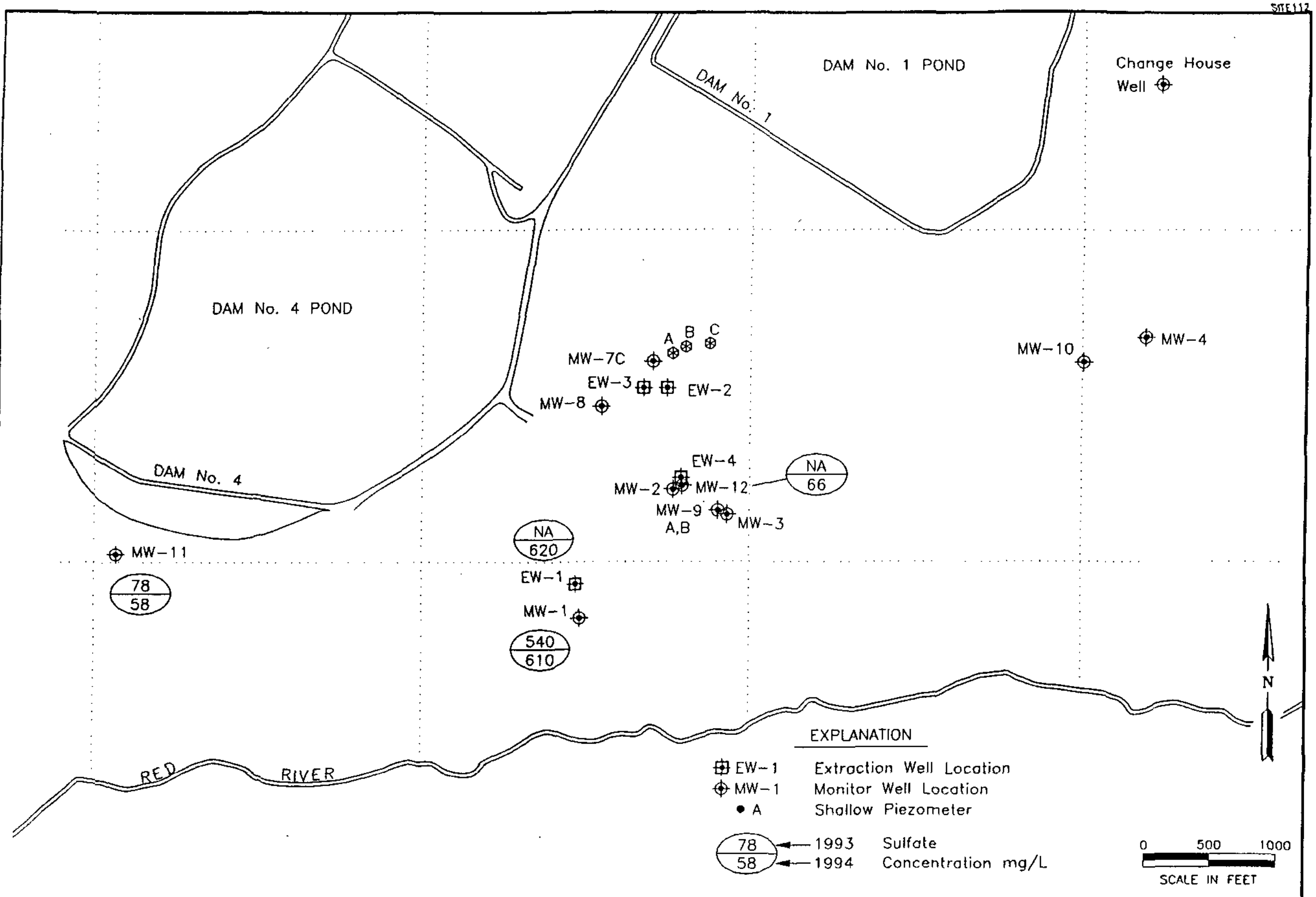


NOTE: All results for wells in LAU except EW-2 in Bouldery Clay

FIGURE: D7	SOUTH PASS RESOURCES, Inc.				SULPHATE CONCENTRATIONS – LAU Tailings Area – Molycorp, Inc. Questa, New Mexico
	PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.	

M-00000542

000492



M-00000543

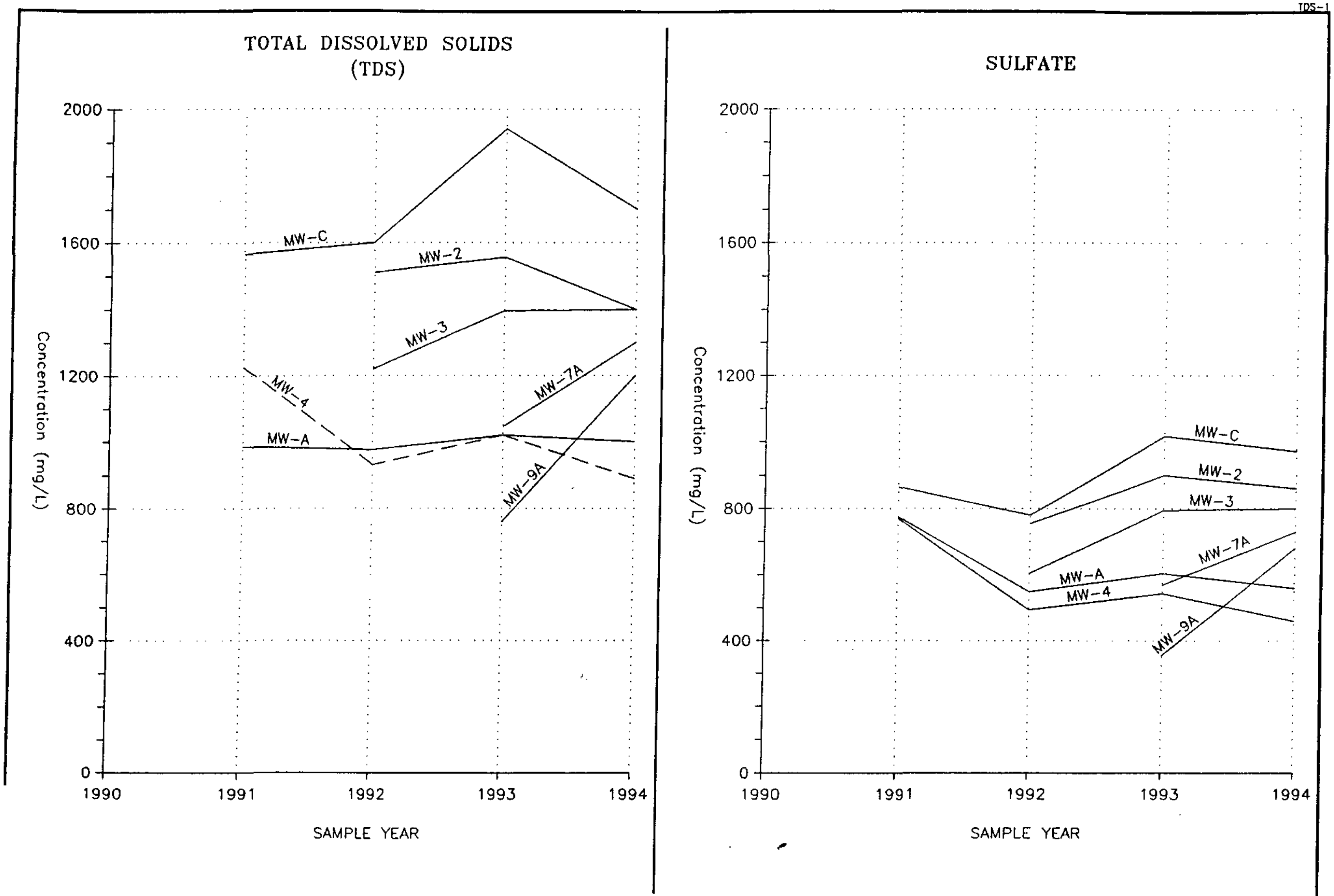
FIGURE: D8

SOUTH PASS RESOURCES, Inc.

PROJECT No.:	DATE:	AUTHOR:	DRAWN BY:
001-06	3/31/95		M.O'M.

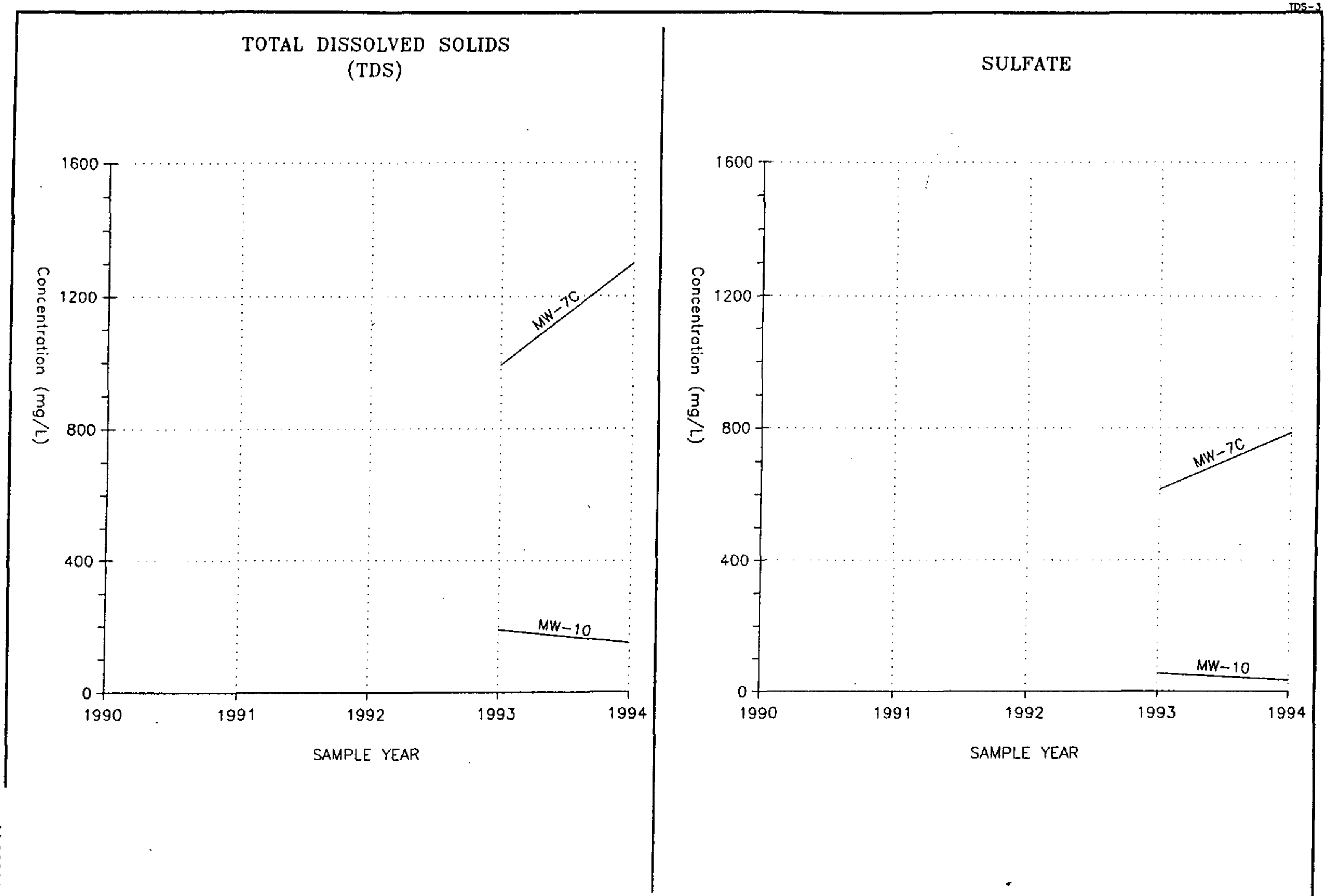
SULPHATE CONCENTRATIONS – BASALT AQUIFER

Tailings Area – Molycorp, Inc.
Questa, New Mexico



M-00000544

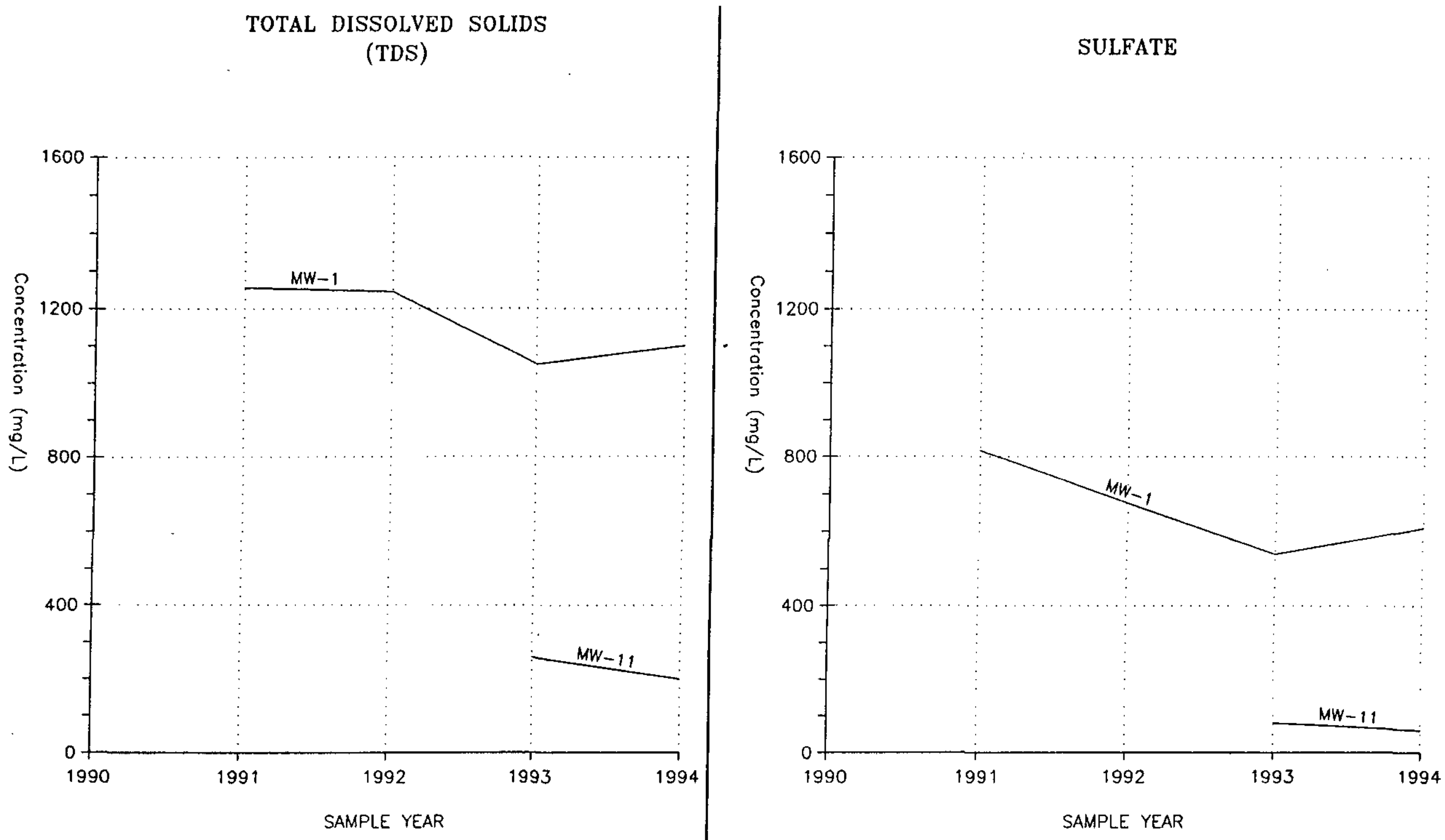
FIGURE: D9	SOUTH PASS RESOURCES, Inc.				TDS AND SULFATE vs TIME – PERCHED AQUIFER Tailings Area – Molycorp, Inc. Questa, New Mexico
	PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.	



M-00000545

FIGURE: D 10	SOUTH PASS RESOURCES, Inc.				TDS AND SULFATE vs TIME – LAU AQUIFER
	PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.	Tailings Area – Molycorp, Inc. Questa, New Mexico

TDS-2



M-00000546

FIGURE: D 11	SOUTH PASS RESOURCES, Inc.				TDS AND SULFATE vs TIME – BASALT AQUIFER Tailings Area – Molycorp, Inc. Questa, New Mexico
	PROJECT No.: 001-06	DATE: 3/31/95	AUTHOR:	DRAWN BY: M.O'M.	

TABLE D1
1994 MONITOR WELL WATER QUALITY DATA FOR TAILINGS AREA
MOLYCORP, INC. - QUESTA, NEW MEXICO
(Page 1 of 3)

MONITOR WELL	SAMPLE DATE 1994	WELL TD (feet)	Corrected DEPTH TO WATER (feet)	DEPTH TO PUMP INTAKE (feet)	pH (1)	CONDUC-TIVITY (1) (uhmos)	TEMP (1) (°C)	CARBO-NATE (mg/L)	BICARBO-NATE (mg/L)	HYDR-OXIDE (mg/L)	TOTAL ALK (mg/L)	CHLORIDE (mg/L)	FLUORIDE (mg/L)	NITRATE (mg/L)	SUFATE (mg/L)
EW-1	7-Nov	157	83.00	102	7.50	1,460	NA	<1	156	<1	156	23	0.25	0.72	620
EW-2	8-Nov	204	147.91	170	7.48	850	12.9	<1	122	<1	122	4.8	0.49	0.2	96
EW-2	17-Nov	NA	NA	NA	NA	NA	NA	<1	118	<1	118	4.6	0.5	0.38	90
EW-3	8-Nov	78	57.74	70	7.48	1,135	11.4	<1	110	<1	110	17	0.16	0.6	440
EW-3	19-Nov	NA	NA	NA	NA	NA	NA	<1	136	<1	136	18	0.19	0.49	410
EW-4	7-Nov	58	18.49	50	7.78	650	11.6	<1	152	<1	152	26	0.21	0.35	150
EW-4	16-Nov	NA	NA	NA	NA	NA	NA	<1	156	<1	156	26	0.2	0.36	160
MW-1	7-Nov	100	53.17	80	7.28	1,322	NA	<1	136	<1	136	14	0.27	0.45	610
MW-2	7-Nov	80	22.07	60	7.96	1,701	NA	<1	80	<1	80	15	0.96	<0.06	860
MW-3	8-Nov	60	19.97	55	7.38	1,679	12.4	<1	183	<1	183	18	0.44	0.31	780
MW-4	8-Nov	96	40.77	65	7.61	1,157	12.3	<1	184	<1	184	7.3	0.73	0.24	460
MW-7A	7-Nov	90	58.84	80	7.50	1,565	11.9	<1	126	<1	126	16	0.18	0.72	730
MW-7C	9-Nov	146	111.79	135	7.10	2,160	12.4	<1	124	<1	124	16	0.17	0.32	790
MW-9A	8-Nov	44	26.30	35	7.32	1,021	13.1	<1	174	<1	174	20	0.44	0.33	680
MW-10	8-Nov	129	26.23	100	8.16	236	12.3	<1	77	<1	77	1.6	0.36	0.27	35
MW-11	9-Nov	249	191.93	210	7.00	440	19.8	<1	82	<1	82	10.3	1.28	0.39	58
MW-11AB	9-Nov	NA	NA	NA	NA	NA	NA	<1	79	<1	79	10.1	1.29	NA	58
MW-12	7-Nov	234	128.11	210	NA	NA	NA	<1	120	<1	120	5.1	0.46	NA	66
MW-A	7-Nov	38	30.58	NA	7.28	1,332	NA	<1	154	<1	154	14	0.35	0.37	560
MW-C	7-Nov	14.5	1.80	NA	7.24	1,902	NA	<1	185	<1	185	19	1.16	<0.06	970
CH	8-Nov	NA	NA	NA	7.97	539	13.5	<1	206	<1	206	2.3	0.71	0.44	75

NOTES:

(1) pH, CONDUCTIVITY AND TEMPERATURE WERE RECORDED WHEN SAMPLED.
SOURCE: SAMPLES TAKEN BY SPRI. ANALYTICAL RESULTS FROM MOLYCORP.
NA - NOT AVAILABLE

TABLE D1
1994 MONITOR WELL WATER QUALITY DATA FOR TAILINGS AREA
MOLYCORP, INC. - QUESTA, NEW MEXICO

MONITOR WELL	TDS (mg/L)	SILVER (mg/L)	ALUMINUM (mg/L)	ARSENIC (mg/L)	BARIUM (mg/L)	BERYLLIUM (mg/L)	CALCIUM (mg/L)	CADMIUM (mg/L)	COBALT (mg/L)	CHROMIUM (mg/L)	COPPER (mg/L)	IRON (mg/L)	MERCURY (mg/L)
EW-1	1,200	<0.10	<0.05	<0.005	0.053	<0.004	240	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
EW-2	240	<0.10	<0.05	<0.005	0.068	<0.004	59.4	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
EW-2	290	<0.010	<0.05	<0.005	0.065	<0.004	57.8	0.0036	<0.010	<0.010	<0.010	<0.050	<0.0002
EW-3	830	<0.10	<0.05	<0.005	0.074	<0.004	179	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
EW-3	750	<0.010	<0.05	<0.005	0.054	<0.004	158	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
EW-4	440	<0.10	<0.05	<0.005	0.065	<0.004	101	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
EW-4	450	<0.010	<0.05	<0.005	0.068	<0.004	104	<0.0005	<0.010	<0.010	0.012	<0.050	<0.0002
MW-1	1,100	<0.10	<0.05	<0.005	0.025	<0.004	207	<0.0005	<0.010	<0.010	<0.010	0.068	<0.0002
MW-2	1,400	<0.10	<0.05	<0.005	0.022	<0.004	241	<0.0005	<0.010	<0.010	<0.010	4.6	<0.0002
MW-3	1,400	<0.10	<0.05	<0.005	0.032	<0.004	264	<0.0005	<0.010	<0.010	<0.010	0.07	<0.0002
MW-4	890	<0.10	<0.05	<0.005	0.084	<0.004	166	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-7A	1,300	<0.10	<0.05	<0.005	0.028	<0.004	273	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-7C	1,300	<0.10	<0.05	<0.005	0.028	<0.004	279	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-9A	1,200	<0.10	<0.05	<0.005	0.061	<0.004	247	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-10	150	<0.10	<0.05	<0.005	0.038	<0.004	28.2	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-11	200	<0.10	<0.05	<0.005	0.014	<0.004	28.6	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-11AB	220	<0.10	<0.05	<0.005	0.015	<0.004	28.5	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-12	260	<0.10	<0.05	<0.005	0.096	<0.004	47.1	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
MW-A	1,000	<0.10	<0.05	<0.005	0.03	<0.004	214	<0.0005	<0.010	<0.010	<0.010	0.066	<0.0002
MW-C	1,700	<0.10	<0.05	<0.005	0.04	<0.004	334	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002
CH	340	<0.10	<0.05	<0.005	0.059	<0.004	48.5	<0.0005	<0.010	<0.010	<0.010	<0.050	<0.0002

NOTES:

(1) pH, CONDUCTIVITY AND TEMPERATURE WERE RECORDED WHEN SAMPLED.

SOURCE: SAMPLES TAKEN BY SPRI. ANALYTICAL RESULTS FROM MOLYCORP.

NA - NOT AVAILABLE

TABLE D1
1994 MONITOR WELL WATER QUALITY DATA FOR TAILINGS AREA
MOLYCORP, INC. - QUESTA, NEW MEXICO

MONITOR WELL	POTASSIUM (mg/L)	MAGNESIUM (mg/L)	MANGANESE (mg/L)	MOLYBDENUM (mg/L)	SODIUM (mg/L)	NICKEL (mg/L)	LEAD (mg/L)	ANTIMONY (mg/L)	SELENIUM (mg/L)	SILICON (mg/L)	THALLIUM (mg/L)	VANADIUM (mg/L)	ZINC (mg/L)
EW-1	3.7	47.9	0.017	<0.02	41.7	<0.020	<0.002	<0.05	<0.005	13.8	<0.005	<0.010	<0.050
EW-2	3.3	10.4	0.169	<0.02	20.0	<0.020	<0.002	<0.05	<0.005	15.7	<0.005	<0.010	<0.050
EW-2	3.6	10	0.138	<0.02	19.6	<0.020	<0.002	<0.05	<0.005	17.3	<0.005	<0.010	0.091
EW-3	2.6	31.8	0.056	<0.02	28.6	<0.020	<0.002	<0.05	<0.005	12.4	<0.005	<0.010	<0.050
EW-3	2.2	27.8	0.036	<0.02	28.9	<0.020	<0.002	<0.05	<0.005	11.9	<0.005	<0.010	0.364
EW-4	1.5	17.8	<0.010	<0.02	15.5	<0.020	<0.002	<0.05	<0.005	12.4	<0.005	<0.010	<0.050
EW-4	2.1	18.1	0.019	<0.02	16	<0.020	<0.002	<0.05	<0.005	12.7	<0.005	<0.010	0.364
MW-1	3.0	41.2	0.035	0.04	55.4	<0.020	<0.002	<0.05	<0.005	11.9	<0.005	<0.010	<0.050
MW-2	3.1	52.2	0.37	1.7	95.6	<0.020	<0.002	<0.05	<0.005	1.8	<0.005	<0.010	<0.050
MW-3	1.5	48.6	0.032	<0.02	71.6	<0.020	<0.002	<0.05	<0.005	10.3	<0.005	<0.010	<0.050
MW-4	1.1	32.7	<0.010	0.21	64.2	<0.020	<0.002	<0.05	<0.005	10.3	<0.005	<0.010	<0.050
MW-7A	2.6	47.1	<0.010	<0.02	39.5	<0.020	<0.002	<0.05	<0.005	12.3	<0.005	<0.010	<0.050
MW-7C	3.9	48.4	<0.010	<0.02	45.1	<0.020	<0.002	<0.05	<0.005	12.1	<0.005	<0.010	<0.050
MW-9A	1.7	45.5	0.111	<0.02	66.0	<0.020	<0.002	<0.05	<0.005	10.5	<0.005	<0.010	<0.050
MW-10	1.3	4.4	<0.010	<0.02	14.7	<0.020	<0.002	<0.05	<0.010	10.8	<0.005	<0.010	<0.050
MW-11	2.8	8.6	<0.010	0.06	25.8	<0.020	<0.002	<0.05	<0.005	15.5	<0.005	<0.010	<0.050
MW-11AB	2.6	8.6	<0.010	0.06	25.7	<0.020	<0.002	<0.05	<0.005	15.5	<0.005	0.01	<0.050
MW-12	2.9	8.5	<0.010	0.02	24.5	<0.020	<0.002	<0.05	<0.005	13.6	<0.005	<0.010	<0.050
MW-A	2.8	35.7	0.04	0.63	50.6	<0.020	<0.002	<0.05	<0.005	10.9	<0.005	<0.010	<0.050
MW-C	2.1	56.1	0.774	1.12	82.2	<0.020	<0.002	<0.05	<0.005	11.6	<0.005	<0.010	<0.050
CH	1.2	9.4	<0.010	<0.02	57.8	<0.020	<0.002	<0.05	<0.005	9.8	<0.005	<0.010	0.946

NOTES:

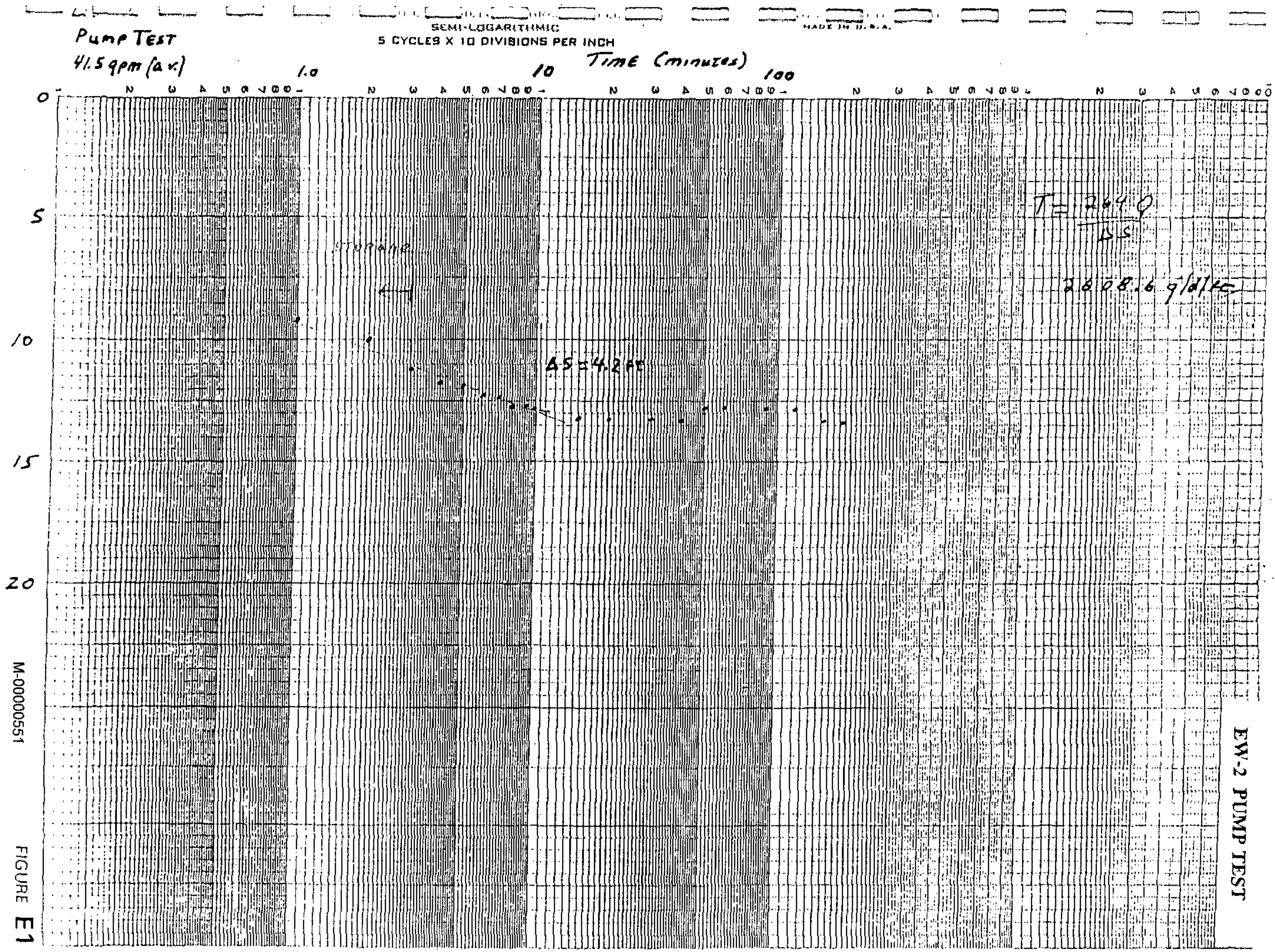
(1) pH, CONDUCTIVITY AND TEMPERATURE WERE RECORDED WHEN SAMPLED.
SOURCE: SAMPLES TAKEN BY SPRI. ANALYTICAL RESULTS FROM MOLYCORP.

NA - NOT AVAILABLE

SOUTH PASS RESOURCES, Inc.
SPRI

APPENDIX E

Data from Tailings Area Aquifer Drawdown and Recovery Tests



EW-2 PUMP TEST

FIGURE E1

M-0000551

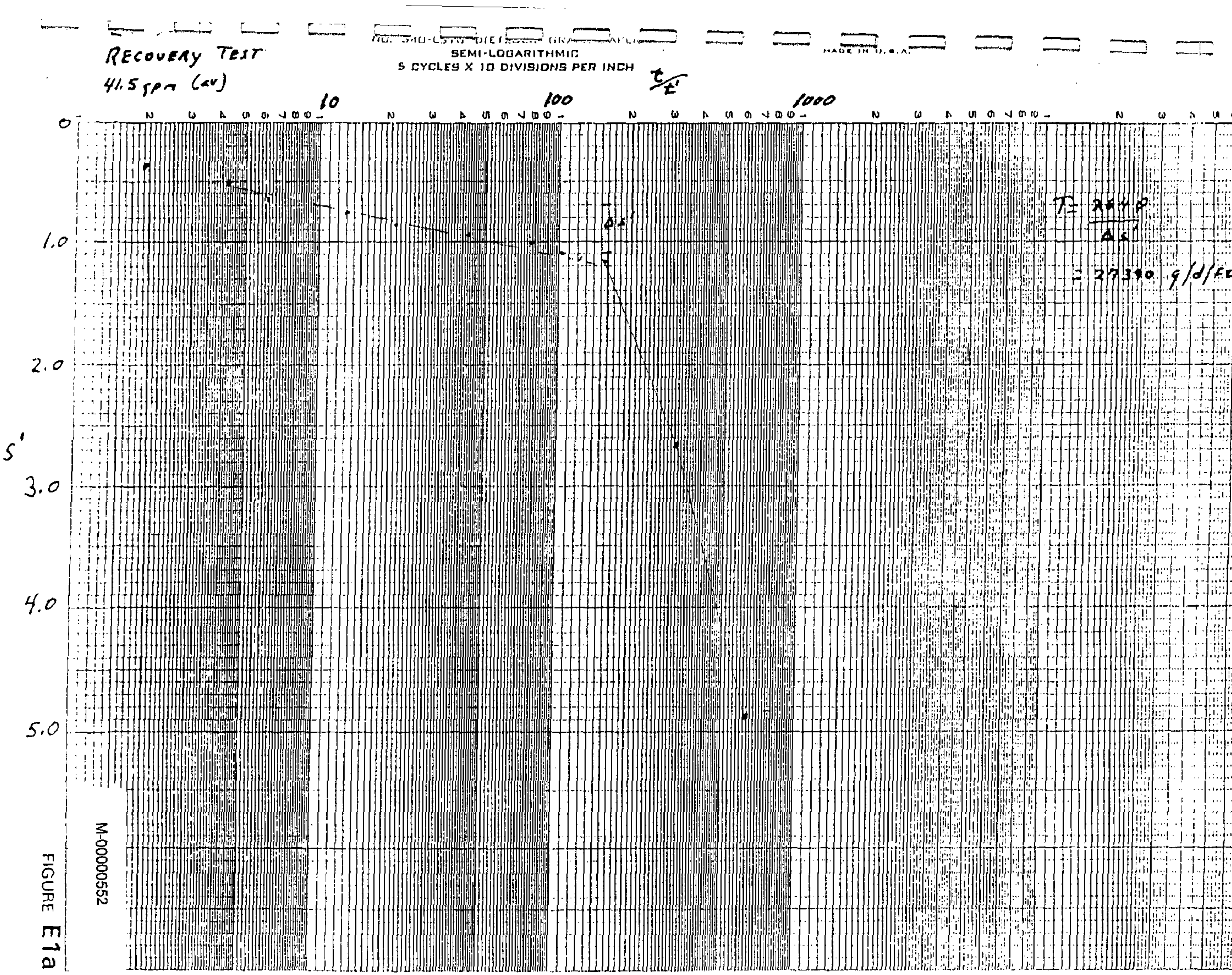


FIGURE E1a

M-00000552

EW-2 RECOVERY TEST

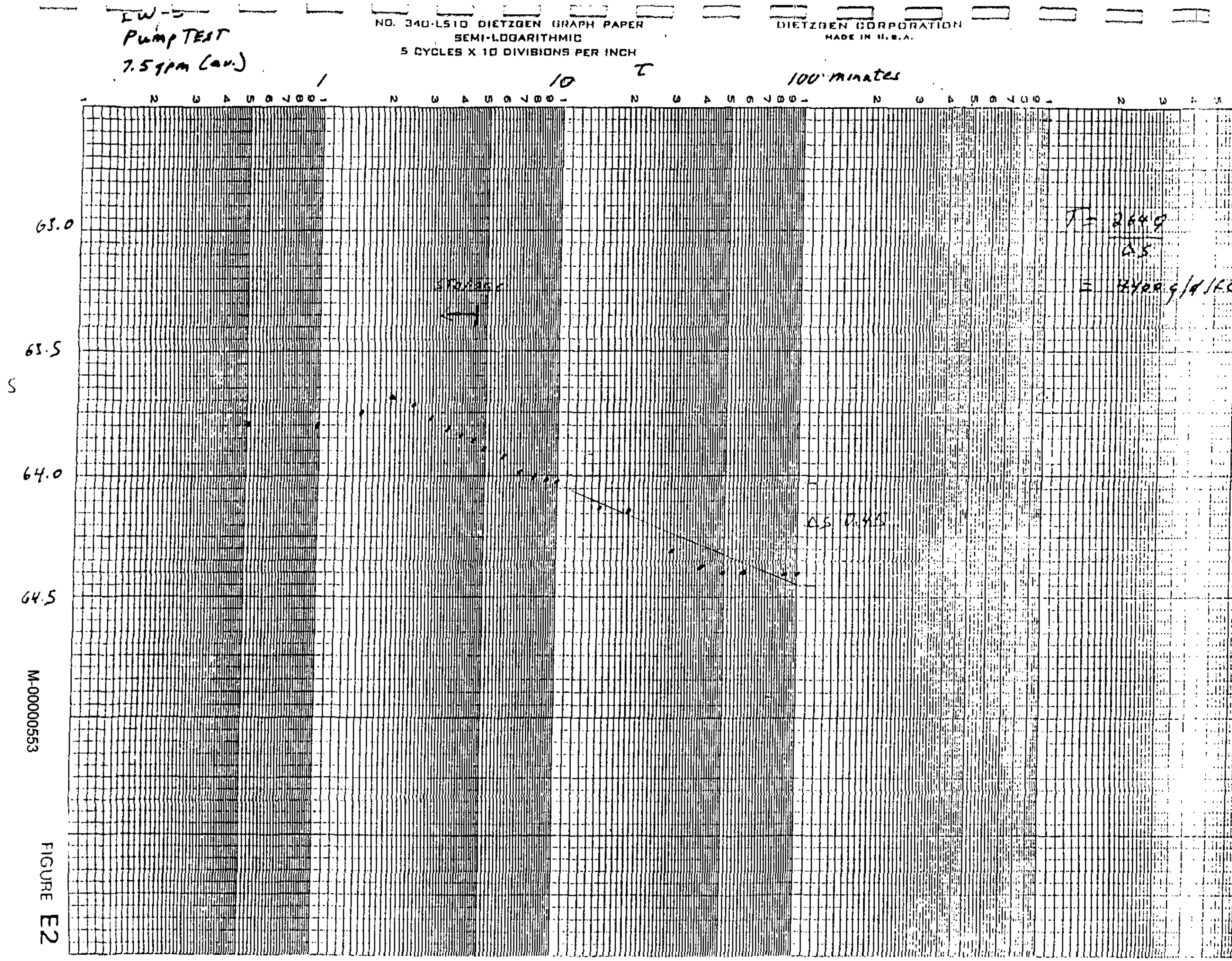
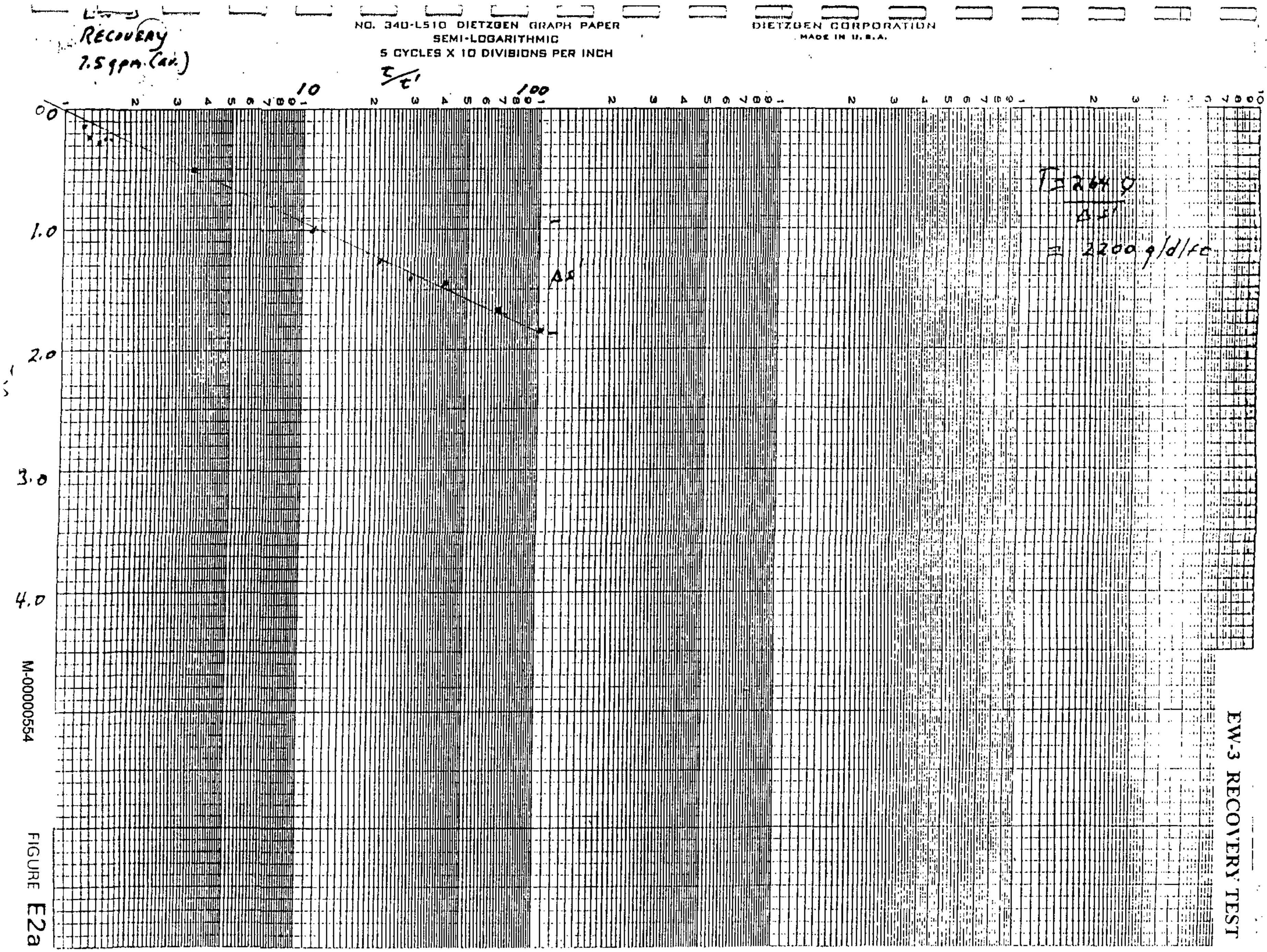


FIGURE E2

EW-3 PUMP TEST

M-0000553

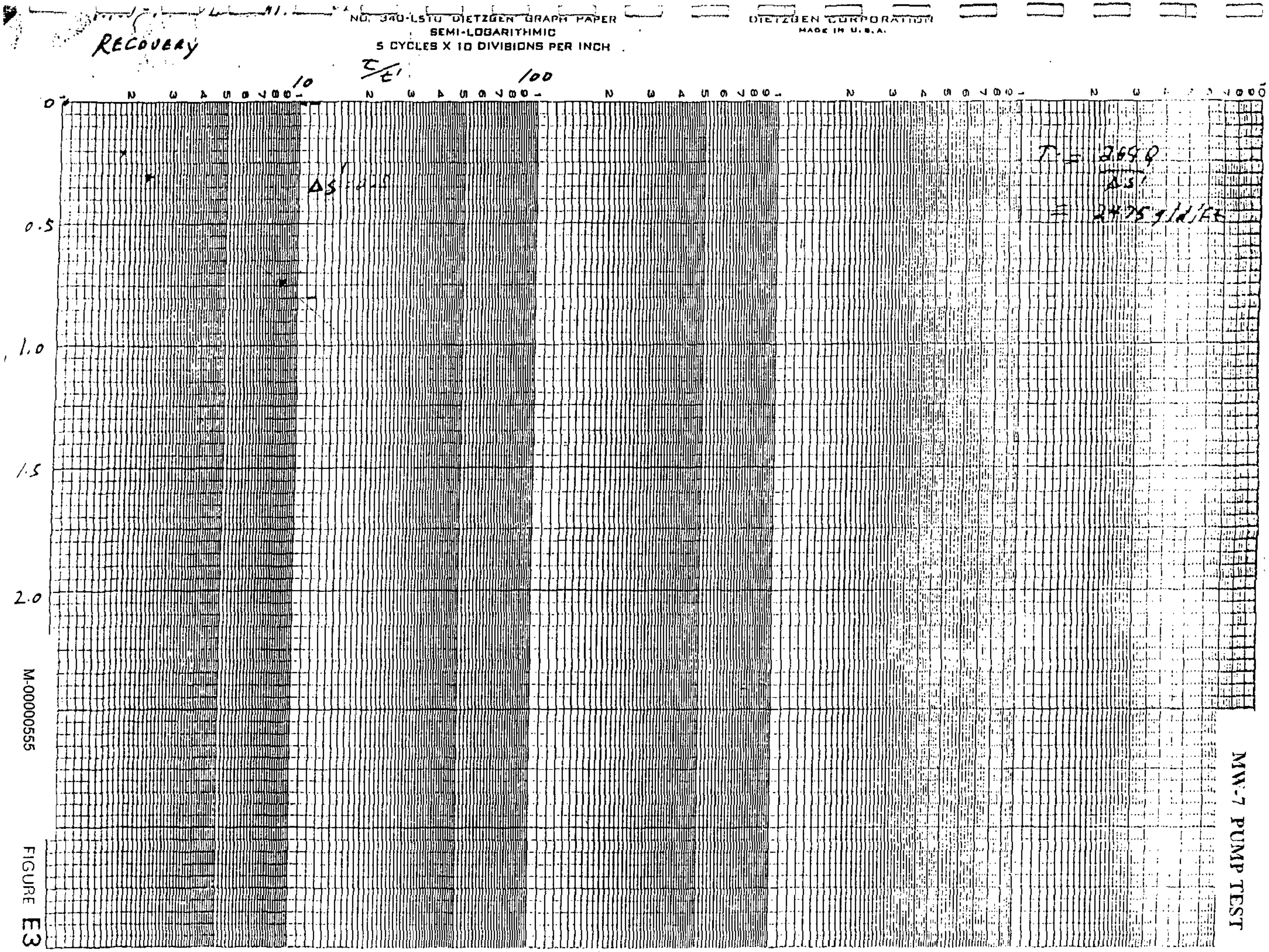


EW-3 RECOVERY TEST

FIGURE E2a

M-0000554

000504



MW-7 PUMP TEST

FIGURE E3

M-0000555

000505

PROBABLE BAROMETRIC-INDUCED CHANGES IN STATIC WATER LEVEL AT MW-7C DURING PASSAGE OF A WEATHER FRONT - NOVEMBER 17, 1994

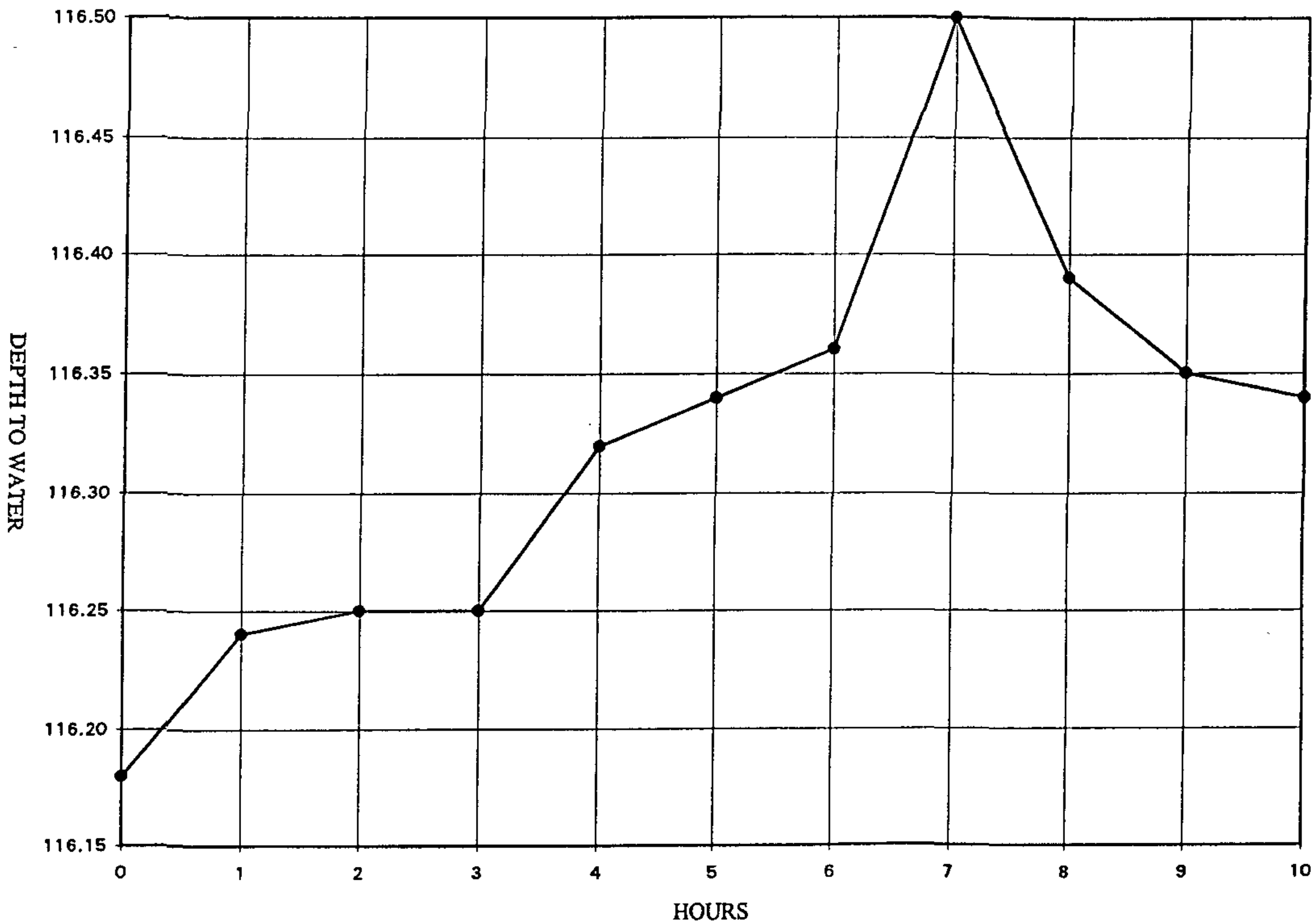


FIGURE E3a

M-00000556